

Technical Cooperation Report for 2019

Report by the Director General



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

Technical Cooperation Report for 2019

Report by the Director General

**GC(64)/INF/9
Printed by the
International Atomic Energy Agency
July 2020**

Preface

The Board of Governors has requested the transmission to the General Conference of the attached Technical Cooperation Report for 2019, the draft of which was considered by the Board at its June 2020 session.

The Director General is also hereby reporting in fulfilment of the request contained in resolution GC(63)/RES/9 on "Strengthening of the Agency's technical cooperation activities".

Contents

<i>Summary</i>	vii
<i>The Agency's Technical Cooperation Programme in Figures</i>	ix
A. Strengthening the Agency's Technical Cooperation Activities	5
A.1. Technical cooperation in 2019: An overview	5
A.2. Building a more efficient, more effective technical cooperation programme	18
B. TC Programme Resources and Delivery	31
B.1. Financial overview	31
B.2. Delivering the technical cooperation programme	34
C. Programme Activities and Achievements in 2019	39
C.1. Africa	39
C.2. Asia and the Pacific	45
C.3. Europe	51
C.4. Latin America and the Caribbean	54
C.5. Interregional projects	59
C.6. Programme of Action for Cancer Therapy (PACT)	61
Annex 1. Achievements in 2019: Project Examples by Thematic Sector	69
Health and Nutrition	69
Food and Agriculture	77
Water and the Environment	85
Industrial Applications	89
Energy Planning and Nuclear Power	93
Radiation Protection and Nuclear Safety	99
Nuclear Knowledge Development and Management	107
Annex 2. TC Programme Fields of Activity	111

Figures

Figure 1: Actuals by technical field for 2019	x
Figure 2: Male/female participation in the TC programme	23
Figure 3: Percentage of male and female NLOs by region	23
Figure 4: Female project counterparts by region, 2015–2019	25
Figure 5: Female participation in training, as fellows, scientific visitors, training course participants, meeting participants and other project personnel, 2015–2019	25
Figure 6: Trends in TC programme resources, 2010–2019	31
Figure 7: Trends in the Rate of Attainment, 2010–2019	32
Figure 8: Trends in extrabudgetary contributions by donor type, excluding contributions to PACT, 2010–2019	34
Figure 9: Actuals in the Africa region in 2019 by technical field	39
Figure 10: Actuals in the Asia and the Pacific region in 2019 by technical field	45
Figure 11: Actuals in the Europe region in 2019 by technical field	51
Figure 12: Actuals in the Latin America and the Caribbean region in 2019 by technical field	54
Figure 13: Interregional actuals in 2019 by technical field	59

Tables

Table 1: TC programme resources in 2019	32
Table 2: Payment of National Participation Costs and assessed programme cost arrears	32
Table 3: Extrabudgetary contributions allotted to TC projects in 2019, by donor (in Euro)	33
Table 4: Funding where the donor is the recipient (Government cost sharing) allotted to TC projects in 2019 (in euros)	33
Table 5: Extrabudgetary contributions to PACT, 2019	33
Table 6: TCF financial indicators for 2017, 2018 and 2019	34
Table 7: Comparison of the unallocated balance of the TCF (in euros)	35
Table 8: Delivery of outputs: non-financial indicators for 2019	35
Table 9: TC procurement in 2019	35
Table 10: Voluntary contributions to the AFRA Fund for TC activities, 2019 (in euros)	43

Summary

The Technical Cooperation Report for 2019 provides an overview of the Agency's Technical Cooperation (TC) activities during the year, covering actions to strengthen the technical cooperation programme, programme resources and delivery, and programme activities and achievements. Specific project activities and achievements are listed in Annex 1 according to thematic area, and Annex 2 lists the TC programme Fields of Activity, grouped for reporting purposes. The report responds to General Conference resolution GC(63)/RES/9.

Part A.1 presents the context for the technical cooperation programme in 2019, describing the Agency's efforts to participate in global development dialogue through attendance at significant United Nations meetings and conferences such as the Second High-level United Nations Conference on South-South Cooperation, the High-level Political Forum, and high level meetings of the United Nations General Assembly. Other important events with Agency participation included the Africa Food Security Leadership Dialogue (AFSLD), and the Seventh Tokyo International Conference on African Development.

The TC programme is designed to address the specific needs and priorities of each country and region. Part A.1 also provides examples of regional efforts in this regard, while subsequent sections present examples of how the programme contributes to the attainment of the Sustainable Development Goals (SDGs), as well as how it addresses the needs of least developed countries (LDCs) and supports responses to emergencies. An overview of Agency actions to develop human resources and build capacities is then provided, focusing on third level and postgraduate education, and on specialized schools and courses. The section closes with an overview of efforts to build awareness of the TC programme, through outreach, events, and participation in targeted conferences and symposia.

Part A.2 focuses on continuing efforts to enhance the efficiency and effectiveness of the TC programme. It describes activities to ensure that projects are linked with Member States' national development plans and other relevant development policies and goals, including United Nations Development Assistance Frameworks (UNDAFs) and SDGs, where applicable. To maximize programme impact, the Agency works in close partnership with Member States, United Nations agencies, national institutes and civil society. Agreements and Practical Arrangements signed in 2019 to support such partnerships are also described in Part A.2. Figures on the participation of women in the TC programme are also presented in this section of the report. Finally, Part A.2 provides an overview of the Agency's activities to improve programme quality in 2019 through workshops, training events and quality reviews and assessments.

Part B presents a summary of financial and non-financial programme delivery indicators. It reviews the resources mobilized for the TC programme through the Technical Cooperation Fund (TCF), and through extrabudgetary and in-kind contributions. Payments to the TCF in 2019 totalled €81.0 million¹, or 94.0% of the TCF target set for the year.² New extrabudgetary resources for 2019 came to €12.3 million and in-kind contributions were €0.3 million. Overall, implementation for the TCF reached 89.1% in 2019, and health and nutrition, safety and security, and food and agriculture were the top areas of disbursement for the programme.

Part C highlights programme activities and achievements, and covers assistance to Member States in the peaceful, safe, and secure application of nuclear science and technology. It highlights regional and interregional

¹ This figure does not include National Participation Costs, assessed programme cost arrears and miscellaneous income.

² Total payments received in 2019 include €24 600 either of deferred or of additional payments by 9 Member States. Excluding these payments, the 2019 rate of attainment on payments would have still been 94.0%.

activities and achievements in technical cooperation in 2019, and presents an overview of the activities of the Programme of Action for Cancer Therapy (PACT).

Project examples are presented in Annex 1 according to thematic area, covering health and nutrition, food and agriculture, water and the environment, industrial applications, energy planning and nuclear power, radiation protection and nuclear safety, and nuclear knowledge development and management. Annex 2 lists the technical cooperation programme Fields of Activity

The Agency's Technical Cooperation Programme in Figures

(as at 31 December 2019)



³ Including TCF payments, National Participation Costs and miscellaneous income.

⁴ Includes donor contributions and government cost-sharing. Please refer to Table A.5 of the Supplement to this report for details.

⁵ Year-end budget is the total value of all technical cooperation activities approved and funded for a given calendar year plus all approved assistance brought forward from previous years but not yet implemented.

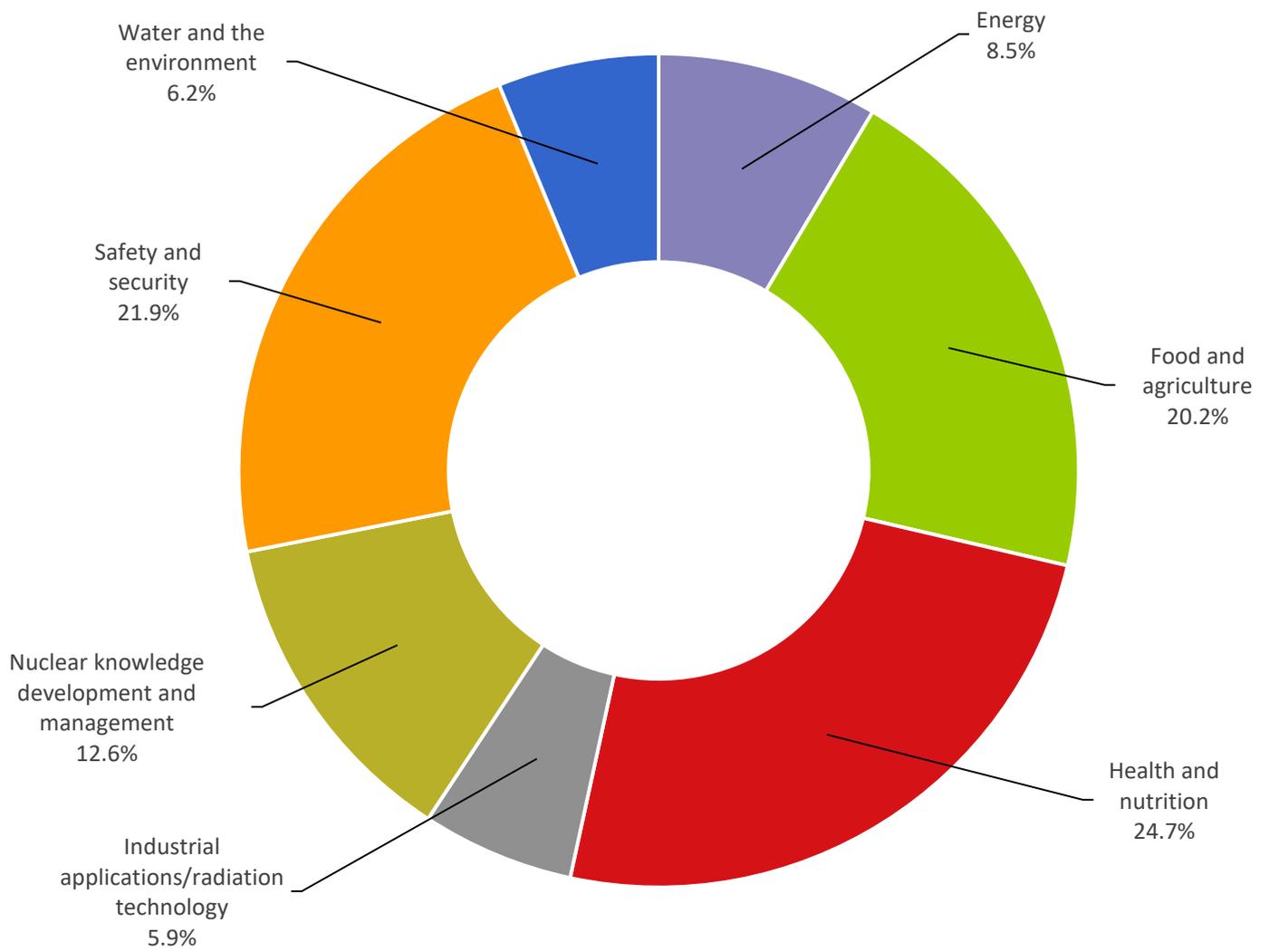


Figure 1: Actuals by technical field for 2019.⁶

⁶ Throughout this report, percentages in charts may not add up to 100% exactly due to rounding.

Technical Cooperation Report for 2019

Report by the Director General

This document responds to the request by the General Conference to the Director General to report on the implementation of resolution GC(63)/RES/9.

Part A of the report provides an overview of the progress achieved in delivering the technical cooperation programme in 2019.

Part B reports on the management of financial resources and programme delivery at an aggregate level in the calendar year 2019.

Part C reports on regional activities and programme achievements during 2019.

Annex 1 provides examples of project activities and achievements in specific thematic areas.

Annex 2 lists the technical cooperation programme Fields of Activity



A. Strengthening the Agency's Technical Cooperation Activities

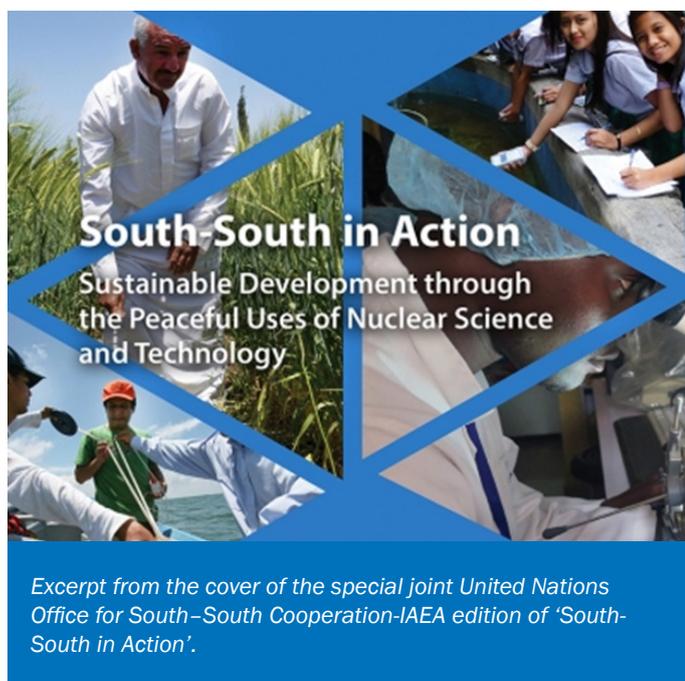
A. Strengthening the Agency's Technical Cooperation Activities⁷

A.1. TECHNICAL COOPERATION IN 2019: AN OVERVIEW⁸

Global developments in 2019: The context for the TC programme⁹

Global development dialogue

The Second High-level United Nations Conference on South-South Cooperation (BAPA+40) took place in Buenos Aires from 20 to 22 March 2019, four decades after the adoption of the original Buenos Aires Plan of Action for Promoting and Implementing Technical Cooperation among Developing Countries (BAPA). The event drew almost 4000 participants from 160 countries and a range of civil society, private sector and academic



Excerpt from the cover of the special joint United Nations Office for South-South Cooperation-IAEA edition of 'South-South in Action'.

institutions, with an estimated 14 million people following the proceedings through different online channels. The IAEA attended and launched a special joint United Nations Office for South-South Cooperation-IAEA edition of 'South-South in Action', focusing on the contribution of nuclear science and technology in agriculture, health, industry, energy, water management and environmental monitoring. The Agency also hosted a side event with States Parties to the Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) and to the African Regional Co-operative

"The IAEA attended and launched a special joint United Nations Office for South-South Cooperation-IAEA edition of 'South-South in Action', focusing on the contribution of nuclear science and technology in agriculture, health, industry, energy, water management and environmental monitoring."

⁷ Section A responds to section A.1, operative paragraph 3, of resolution GC(63)/RES/9 on assist Member States in the peaceful, safe and secure application of nuclear science and technologies; section A.2, operative paragraph 2 on strengthening TC activities through the development of effective, efficient and outcomes oriented programmes; section A.2, operative paragraph 4 on contributing to the implementation of the principles expressed in the Istanbul Declaration and the Programme of Action for the Least Developed Countries for the Decade 2011–2020, and to the attainment of internationally agreed development goals including the SDGs; section A.4, operative paragraph 6 on supporting Member States' development efforts, including the attainment of the SDGs; and to section A.5, operative paragraph 4 on promoting TC activities supporting the self-reliance, sustainability and further relevance of national nuclear and other entities in Member States, and enhancing regional and interregional cooperation.

⁸ Section A.1 responds to section A.2, operative paragraph 8, of resolution GC(63)/RES/9 on examining characteristics and problems of LDCs and addressing this matter.

⁹ This section responds to section A.5, operative paragraph 2, of resolution GC(63)/RES/9 on consultations and interactions with interested States, the UN system, multilateral financial institutions, regional development bodies and other relevant intergovernmental and non-governmental bodies and participating in the HLPF; and section A.5, operative paragraph 3 on participation and contribution with respect to South-South and triangular cooperation.

Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) to showcase the achievements of nuclear science and technology for sustainable development.

In July, a series of events in and around the High-level Political Forum on Sustainable Development (HLPF), the UN’s main mechanism for follow-up and review of the 2030 Agenda, offered the Agency an opportunity to highlight its contribution to Member States’ efforts to achieve the SDGs. In 2019, the HLPF convened twice, once under the auspices of United Nations Economic and Social Council (ECOSOC) for its regular annual session in July, and again at the SDG Summit under the auspices of the UN General Assembly from 24 – 25 September. Agency representatives attended both segments of the Forum, signaling the importance of the 2030 Agenda to the work of the Agency. In July, the Agency’s participation at the HLPF enabled its attendance at the ECOSOC Integration Segment and at the Global Multi-stakeholder Small Island Developing States (SIDS) Partnership Dialogue, raising awareness of the Agency’s work in these areas.

In September, Agency good practices and success stories were featured at a video exhibit at a week of high level meetings of the United Nations General Assembly, which included the Climate Action Summit, the High-level Meeting on Universal Health Coverage, the SDG Summit, the High-level Dialogue on Financing for Development, and the High-level Midterm Review of the Small Island Developing States Accelerated Modalities of Action Pathway. The SDG Summit focused on ‘Gearing up for a decade of action and delivery’, calling for collective responses and accelerated actions in order to achieve the Global Goals. The 2019 Global Sustainable Development Report, ‘The Future is Now’, launched during Summit Week, highlighted the importance of science in achieving the 2030 Agenda and called for increased investment in science for sustainability.

For the third consecutive year, the Agency engaged actively in the dialogue leading to the

publication of the annual Financing for Sustainable Development Report, a joint product of the members of the Inter-Agency Task Force on Financing for Development, coordinated by the Financing for Sustainable Development Office of the United Nations Department of Economic and Social Affairs (UNDESA). The Report issued in 2019 noted that the Agency’s work in science, technology and innovation is helping countries to address key development priorities, as well as assisting in the establishment of national legal frameworks for the safe, secure and peaceful use of nuclear science and technology. The Agency’s input to the 2020 Report, which will be issued this year, offered concrete examples of the contributions of nuclear science and technology to the attainment of the SDGs in climate adaptation and mitigation, in the development and transfer of pest control techniques for improved plant, animal and human health, in tissue engineering applied to regenerative medicine, and in increased production and accelerated economic development.

In August 2019, the Agency took part in the Africa Food Security Leadership Dialogue, which aims to strengthen the coordination of development partners and regional initiatives in support of country efforts to achieve common food and security goals. Agreement was reached to leverage climate smart agriculture and food systems to meet the dietary needs of the fast-growing African population, for which the TC programme contribution can be of high value.

The Seventh Tokyo International Conference on African Development (TICAD7), focusing on ‘Advancing Africa’s Development through People, Technology and Innovation’, was held in Yokohama, Japan, in August 2019. More than 10 000 people participated, including 42 African leaders from 53 African countries, 52 development partner countries, 108 heads of international and

Algeria
IAEA Member State since December 1963

Key achievements in Algeria

- 2010: More than 30 Linear Accelerators are operational in line with the National Cancer Plan.
- 2018: National Nuclear Medicine Network established, made up of more than 40 Units and including the first positron emission tomography-computed tomography (PET-CT) scanner in a public hospital.
- Hosts 4 African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) regional designated centres.

Recent project successes

Nuclear instrumentation
The Nuclear Instrumentation Division of the Brine Nuclear Research Centre is in charge of the maintenance, repair and realising of nuclear instruments, and of training staff. Beginning with a small group of technicians, the Division developed and offered maintenance services locally and provided training (many organized by IAEA and AFRA) to users in IAEA Member States within the AFRA region. IAEA projects and training events enabled the skills of the staff to be strengthened and kept continuously up-to-date. Adequate infrastructure for maintenance, repair and training has been put progressively in place.

Livestock production
Assistance provided through an IAEA project to strengthen animal health and livestock production improved diagnostic and reproductive capacities in animal breeding and supported expertise for a feasibility study for a bioprotection laboratory. Support was provided to the National Institute of Veterinary Medicine (NIMV) in the form of training in epidemiology and the diagnosis of abortive diseases. Equipment was also provided to enhance the Institute's work on pathogen affecting fertility, protocols for oestrus synchronization (female sexual receptivity and fertility) and embryo transfer. IAEA support to the laboratory has contributed to NIMV's certification for competence in testing and calibration of laboratories in December 2014 under ISO/IEC 17025:2005 with regard to the diagnosis of animal pathologies.

Cancer control
Through its National Cancer Plan 2015-2019, Algeria has made a huge effort to offer its cancer patients effective cancer treatment. New cancer centres are planned, offering clinical services in radiation oncology and nuclear medicine, with other related departments acquiring advanced equipment. The national TC programme has supported the upgrading of skills in all staff categories (nuclear physicians, medical physicists, radiation oncologists and technologists) and in patient safety for modern radiotherapy and nuclear medicine techniques. It additionally established local clinical training programmes in medical physics.

Atoms for peace and development
The International Atomic Energy Agency is the world's central intergovernmental forum for scientific and technical cooperation in the nuclear field. It works for the safe, secure and peaceful uses of nuclear science and technology, contributing to international peace and security.
The IAEA's technical cooperation (TC) programme helps countries to use nuclear science and technology to address key development priorities, in areas including health, agriculture, water, the environment and industry. The programme also helps countries to identify and meet future energy needs. It supports greater radiation safety and nuclear security, and provides legislative assistance.

With IAEA support, the Nuclear Instrumentation Division of the Brine Nuclear Research Centre developed local maintenance services and now provides training for users in IAEA Member States within AFRA region.
(Photo: M. Saaloum/COMENA)

Sustainable Development Goals

New outreach material presenting IAEA support to individual countries, was distributed at the Seventh Tokyo International Conference on African Development.

regional organizations, and representatives of civil society and the private sector. The Yokohama Declaration 2019, adopted at TICAD7, highlighted, inter alia, the important role of science, technology and innovation in building sustainable and resilient societies, and called for accelerated action to increase the development and productivity of climate-smart agriculture. A high-level delegation from the Agency attended the Ministerial meeting and the Summit, and seized the opportunity to sensitize Heads of State and delegations on the various applications of nuclear science and technology for development, and on the specific role of the IAEA's technical cooperation programme. New outreach material, focusing on TC support in individual countries, was distributed at the Conference.

The Agency participated in the Ministerial session of the African Union Commission's (AUC) Specialized Technical Committee on Education, Science and Technology in 2019, under the framework of Practical Arrangements signed with the AUC in 2018. Ministers requested the AUC to develop research, development and education activities in nuclear science and technology in Africa, in close cooperation with the IAEA and strategic partners.



The Agency was presented with an award recognizing its contribution to the prevention and control of NCDs during the UNIATF 'Friends of the Task Force' side event at the United Nations General Assembly High-level Meeting on Universal Health Coverage. (Photo: WHO)

The United Nations Interagency Task Force on the Prevention and Control of Non-communicable Diseases (UNIATF) presented the Agency with an award recognizing its contribution to the prevention and control of non-communicable diseases. The award highlighted the IAEA's contribution to efforts to address cancer, obesity and other non-communicable diseases in Latin America and the Caribbean. The contribution of the IAEA technical cooperation programme to the Caribbean community's fight against non-communicable diseases was also highlighted at the 10th UN- Caribbean Community (CARICOM) General Meeting. The text of the joint statement adopted at that meeting acknowledges the Agency's key contributions to health system development in the Caribbean region.

As part of the SIDS, IAEA Member States of the Caribbean region share many of the same challenges concerning human health, food and agriculture, terrestrial and marine environments, water resources and energy planning. In 2019, the Agency sought to broaden its scope of cooperation with CARICOM, its technical institutions and the Pan American Health Organization. The Agency and CARICOM institutions collaborated on numerous initiatives under existing Practical Arrangements, including the development of regional projects for the 2020–2021 TC cycle, as well as the facilitation of regional training courses and the preparation of the first-ever Regional Strategic Framework for Technical

“The award highlighted the IAEA's contribution to efforts to address cancer, obesity and other non-communicable diseases in Latin America and the Caribbean.”

Cooperation with IAEA-CARICOM Member States. The framework document will provide a guideline for the design of future TC programmes to address the interests of all Caribbean region Member States.

Tailoring the TC programme to Member State needs¹⁰

The Agency's TC programme is designed to address the specific needs of Member States, particularly developing countries and LDCs. These needs are identified through the Country Programme Framework (CPF) based on national development plans, sectoral strategies, regional profiles and other relevant programming strategies, such as the 2030 Agenda, including the SDGs, and United Nations Sustainable Development Cooperation Frameworks.

Regional cooperative agreements in Africa, Asia and the Pacific, and Latin America and the Caribbean support the identification of common challenges and the optimal use of skills, facilities and services in a region. The regional cooperative agreements share experience and collaborate through a Quadripartite Forum that meets on the margins of the annual IAEA General Conference.

Contributing to the Sustainable Development Goals

Nuclear science and technology offer a significant contribution to the achievement of several of the SDGs, and support evidence-based decision-making by Member States. The technical cooperation programme supports the achievement of the SDGs. When developing their Country Programme Framework and their national technical cooperation programme, Member States are encouraged to identify linkages between national technical cooperation projects and the SDGs where appropriate.

The implementation of the TC programme in 2019 contributed positively to the efforts of Member States to achieve SDGs 2 (Zero Hunger) and 3 (Good Health and Well-being) by building capacities in the areas of human health, food and agriculture. Other thematic areas supported by the TC programme, such as industrial applications, energy planning, protection of the environment, water management, and nuclear knowledge management, also contributed to the achievement of important development goals, including SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 13 (Climate Action), SDG 15 (Life on Land) and SDG 17 (Partnerships for the Goals).

In Thailand, the TC programme contributed to SDG 2 (Zero Hunger) by helping fruit farmers to use a radiation-based insect pest control technique to rid their farms of the Oriental fruit fly, which has devastated crops and livelihoods for years. The sterile insect technique (SIT) was introduced to Thai farmers by the Department of Agricultural Extension, the Institute of Nuclear Technology, in cooperation with the IAEA and the Food and Agriculture Organization of the United Nations. After adding SIT to their insect control methods, farmers are able to meet international export standards, and are exporting up to 4000 tonnes of high-quality fruits each year.

“Nuclear science and technology offer a significant contribution to the achievement of several of the SDGs, and support evidence-based decision-making by Member States. The technical cooperation programme supports the achievement of the SDGs.”

¹⁰ This section responds to section A.3, operative paragraph 1, of resolution GC(63)/RES/9 on strengthening TC activities, including the provision of sufficient resources, based on Member States' needs and priorities, and ensuring that the components of TC projects are readily available.

Addressing the needs of least developed countries

In 2019, 35 LDCs took part in the IAEA's technical cooperation programme.

At an interregional meeting on aligning the technical cooperation programme with the development goals of LDCs, in January 2019, in Vienna, Austria, a cross-regional strategy for the TC programme to enhance the collaborative utilization of institutional resources in LDCs was agreed. The meeting was supported by TC project INT0097, 'Contributing to the Development of Least Developed Countries by Building Human and Institutional Capacities in Nuclear Sciences and Technology'. In August 2019 an interregional workshop held under the same project brought together National Liaison Officers (NLOs) from LDCs in Africa, Asia and the Caribbean, as well as national public relations officers and journalists reporting on nuclear science and technology, to develop communication tools to raise the visibility of the peaceful use of nuclear science and technology in LDCs. The workshop aimed to support national efforts to raise awareness, address public perceptions and demystify the peaceful use of nuclear technology.

LDCs participating in the TC programme in 2019

Afghanistan, Angola, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Djibouti, Eritrea, Ethiopia, Haiti, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Senegal, Sierra Leone, Sudan, Togo, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia

A further interregional technical cooperation project INT0093, 'Applying Nuclear Science and Technology in Small Island Developing States (SIDS) in Support of the Sustainable Development Goals and the SAMOA Pathway', is supporting IAEA Member States that are SIDS in their efforts to achieve the SDGs and the Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway in areas including marine environment, cancer, nutrition and food security. This is the first IAEA project to bring together countries in Africa, the Caribbean and the Pacific that face similar and unique challenges as SIDS. In 2019, SIDS representatives benefitted from TC activities on topics such as Sargassum control, ocean acidification, nutritional testing, crop productivity and water resources.



Discussions at the interregional meeting on aligning the technical cooperation programme with the development goals of LDCs in January 2019 in Vienna, Austria. (Photo: O. Yusuf/IAEA)

Haiti, the only LDC in the Latin America and Caribbean region, initiated an inventory of ionizing radiation sources in 2019, which will be used to support efforts to enhance national radiation safety. Further support will be provided in 2020 to support Haiti's efforts to establish an effective national safety infrastructure. In addition, Haiti's capacities in soil and water management and food safety monitoring have been strengthened, with the goal of increasing agricultural productivity and exportability. The Veterinary and Food Quality Laboratory has enhanced its capacity to test the safety and quality of food and water. Mycotoxin analysis has, for instance, been improved and this is enabling the laboratory to better cooperate with the Quarantine and Inspection Service of the country, in the testing and certification of food imports before they enter the country. The laboratory is also supporting the testing of foods such as plantain, mangoes, coffee, among others, for exports. In addition, national capacities were enhanced through capacity building in the use of isotopes of nitrogen (N-15) and carbon (C-13) in soil-water-nutrient-plant analysis. The new soil-water-plant laboratory's analytical capacities were strengthened through the provision of essential analytical equipment for fast and accurate soil analysis. Field studies to evaluate rice varieties for their efficient nitrogen use (and high productivity) using N-15 techniques have been conducted and stable isotope analysis is in progress.

Invited by the United Nations Under-Secretary-General and High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, the Agency participated in 2019 in the 19th Inter-Agency Consultative Group meeting of the UN system and international organizations on the implementation of the Istanbul Programme of Action for LDCs for the decade 2011–2020, and in preparations for the Fifth UN Conference on LDCs. In December, the Agency also took part in the High-Level Mid-Term Review on the implementation of the Vienna Programme of Action for Landlocked Developing Countries for the decade 2014–2024.

Responding to emergencies

Emergency support was provided to Mozambique under regional project RAF0051, 'Supporting Specific Needs in the African Region Due to Emergencies', following violent storms in May 2019 that killed hundreds of thousands of cattle. The Agency sent equipment and reagents to the central veterinary laboratory in the capital and to regional laboratories in the most affected areas of the country, strengthening their capacities to identify animal and zoonotic diseases that posed outbreak risks after the storms.

Following the 2019 outbreak of African swine fever, the Agency provided emergency support to Cambodia, China, Laos, Mongolia, Myanmar, Thailand and Vietnam for the detection and differentiation of the African swine fever virus. Five field missions to the countries reviewed capacities at national laboratories and disseminated standard operating procedures for diagnostic techniques. Additionally, Member States had access to the Agency laboratories in Seibersdorf information platform iVetNet, for a rapid exchange of validated diagnostic procedures and the sequencing services. Three group fellowship trainings were dedicated to disseminating techniques for the early detection of priority animal and zoonotic diseases.

A joint mission with the World Health Organization (WHO) to Dhaka supported Bangladesh in the worst outbreak of dengue since its first recorded epidemic in 2000. A four-year workplan has been established, covering selection of a pilot site for the release of sterile male mosquitoes in 2021–2022, and a schedule for IAEA technical assistance, in partnership with the Food and Agriculture Organization of the United Nations (FAO), with the aim of suppressing the mosquitoes that spread the disease.

Following a major earthquake in November in Albania, the Agency sent an expert mission to assess selected critical and damaged infrastructure using non-destructive testing (NDT) methods in December. The team conducted an initial damage assessment and trained a local team in NDT techniques.

Honduras experienced a severe outbreak of dengue in 2019, with more than 107 000 cases of the viral disease and at least 175 deaths. The IAEA provided virus detection equipment to be installed in hospitals in San Pedro Sula and Santa Bárbara, which will assist with the quick detection of the virus and thus enable the timely treatment of patients. The Agency is also contributing to the development of an integrated vector control plan by providing expert assistance on the sterile insect technique (SIT).

Honduras also suffered an emergency caused by a severe drought in the 'Dry Corridor' of the country, where thousands of small subsistence farmers depend on rain to raise basic crops such as beans and corn. An IAEA expert mission was dispatched to assist with the collection of water samples in the most critical zones of Lempira, La Paz and Intibucá, and to conduct an isotopic analysis. A detailed report was delivered to Honduran local authorities in 2019, describing the aquifers found in these regions, providing a preliminary characterization of the water quality, and most importantly, identifying the main recharge zones of the aquifers so that they can be protected.



Collecting groundwater for human consumption in Virginia Municipality, Lempira, Honduras.
(Photo: R. Sanchez-Murillo/ National University of Costa Rica)

*“In early 2019, additional funds were mobilized through the technical cooperation programme for the procurement and delivery of critical equipment for the GNP Laboratory, allowing them to further explore the captive rearing of *Philornis*.”*

Galapagos National Park (GNP), Ecuador, is suffering from the rapid and accelerated invasion of the non-endemic parasitic fly, *Philornis downsi*, which threatens the long term conservation of the blue finches of the Galapagos Islands, affecting 20 species of land birds in the archipelago that are found nowhere else in the world. The mangrove finch is among the species most vulnerable to *Philornis*, being critical endangered, with less than 100 mangrove finches in their natural habitat. In early 2019, additional funds were mobilized through the technical cooperation programme for the procurement and delivery of critical equipment for the GNP Laboratory, allowing them to further explore the captive rearing of *Philornis*. Two expert missions in February and May 2019 supported the study and investigation of *Philornis*' basic and reproductive biology, including analyses of the



Personnel from the Galapagos National Park and the Charles Darwin foundation at the Philornis Downsi Laboratory in Galapagos with the specialized equipment donated by the IAEA.
(Photo: Charles Darwin Foundation)

species' mating systems and intersexual selection. Through an additional expert mission, the GNP received support for the elaboration of a TC project that will ensure continuous technical cooperation support throughout the 2020–2021 TC cycle.

Developing human resources and building capacities^{11, 12}

The Agency supports human resource development and capacity building, delivered through national and regional training courses, meetings, fellowships and scientific visits, and the provision of expert advice. The Agency also supports e-learning, curriculum development and other innovative learning approaches, as well as supporting science, technology, engineering and mathematics initiatives in schools.

Technical cooperation among developing countries and networking

The TC programme supports South-South and triangular cooperation, and contributes to the implementation of the principles expressed in the Istanbul Declaration, the Programme of Action for the Least Developed Countries for the Decade 2011–2020 and to the attainment of internationally agreed development goals, including the SDGs. The IAEA's technical cooperation programme also supports the implementation of the New Partnership for Africa's Development.

In Africa, the TC programme in 2019 continued to strengthen human resources and institutional capacity in the various nuclear science and technology areas, in line with the AFRA 2019–2023 Regional Strategic Cooperation Framework and the Regional Programme Framework (RPF) for Africa.

In the Asia and the Pacific region, human resource and institutional capacity development continued in line with the RPF 2018–2028, the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) Medium Term

¹¹ This section responds to section A.2, operative paragraph 1, of resolution GC(63)/RES/9 on facilitating and enhancing the transfer of nuclear technology and know-how among Member States; and section A.5, operative paragraph 3 on participation and contribution with respect to South-South and triangular cooperation.

¹² For PACT's contribution to this area, please see section C.6.

Strategy and Priorities 2018–2023, and the ARASIA Medium Term Strategy 2018–2027. Five regional training events held in Japan strengthened the capacities of nuclear medical professions in several applications, including cardiac multimodality imaging in a clinical-based setting and radiotherapy treatment planning. Over 50 participants from 15 countries were trained on accident prevention in radiation therapy in Putrajaya, Malaysia, and Tel Aviv, Israel, while over 60 people from 18 countries enhanced their skills in delivering training in radiation protection in interventional radiology in Bangkok, Thailand and in Dubai, United Arab Emirates. With trained trainers on the ground, the sustainability of radiation protection capacities in the region can be ensured.

To address the age and gender gap faced by several nuclear institutions in Latin America and the Caribbean and to support the development of new talent for the continued peaceful application of nuclear technologies, the IAEA launched an initiative 'Workshops for Future Nuclear Leaders in Latin America and the Caribbean'. These events aim to identify, support and strengthen the role played by young professionals, particularly young women, in the promotion and implementation of nuclear science and technology in the region. Two of these workshops were organized in 2019, attended by 79 young professionals, 62 of whom were women. The workshops focused on demonstrating the nuclear techniques used by Member States to address development challenges, including isotope hydrology, food irradiation, radiotherapy and many others.



*For many of the participants, the workshop offered a first opportunity to see first-hand several nuclear applications and their benefits.
(Photo: R.S. Aledo/IAEA)*

Third level and postgraduate education

The Agency prioritizes long term human resource development, including through the sponsorship of master's and PhD students as part of technical cooperation projects. In Africa, for example, human resource capacity building remains a crucial part of the TC programme, with increasing emphasis being placed on long term training that leads to academic and professional qualification in the application of nuclear science and technology.

Fifteen PhD students of isotope hydrology are being supported under the project RAF7019, 'Adding the Groundwater Dimension to the Understanding and Management of Shared Water Resources in the Sahel Region'. This project aims to enhance evidence-based decision-making processes for the characterization, management and monitoring of groundwater in the Sahel region. Also, in Africa, thirteen candidates were awarded a fellowship in 2019 to carry out PhD research work in a foreign university through the PhD sandwich programme under the regional AFRA project RAF0052, 'Supporting Human Resource Development in Nuclear Science and Technology'. Under the same project, ten students participated in two-year fellowships at the University of Alexandria, Egypt, and the University of Ghana, graduating with master's degrees in nuclear science and technology in 2019.

In Latin America, 22 radio-oncologists from 15 Latin America countries have graduated from the Master's in Advanced Radiotherapy since 2018. This one-year Master's programme, the first to be offered in the region, co-hosted by the Chilean Arturo López Pérez Foundation (FALP) and the University of Los Andes, with the support of the Chilean Commission of Nuclear Energy (CCHEN), is implemented under the regional ARCAL project RLA6077, 'Taking Strategic Actions to Strengthen Capacities in the Diagnostics and Treatment of Cancer with a Comprehensive Approach'. The programme addresses the shortage of human resources qualified to work with the latest generation of high-precision radiotherapy, and covers intensity modulation, real-time incorporation of high-resolution digital imaging, use of stereotactic techniques, and protocol designs combining the complementarity and versatility of different techniques and treatments.

The TC programme continues to support the two-year Master's of Medical Physics (MMP), a joint programme between ICTP and the University of Trieste. In 2019, the fifth intake (2018–2019) of 20 students from 18 countries – 16 of whom were TC fellows – graduated from the programme, ready to return to work in their home countries. The intake for 2019–2020 completed the academic year and started their hospital placement year, 12 of them with TC sponsorship. The seventh intake of students, for 2020–2021, also arrived to begin their studies. This is the largest cohort so far, with 21 TC sponsored students. Fellows are supported mainly through interregional project INT0095, 'Supporting Member States in Human Capacity Building Related to Nuclear Science and Technology and Quality Management of the Technical Cooperation Programme', and with some resources from national and regional projects. MMP fellows are often the most qualified medical physicists in their home countries after returning from the ICTP and are expected to pass on their knowledge to colleagues.

Specialized Schools and Postgraduate Courses

The Postgraduate Educational Course (PGEC) in Radiation Protection and the Safety of Radiation Sources is a comprehensive training programme that targets young professionals, primarily from national regulatory bodies. The course aims to help students acquire a sound basis in radiation protection and the safety of radiation sources. An impact evaluation of the PGEC, conducted in 2015, confirmed that the course plays an important role in building a core of professionals competent in radiation protection, as well as in strengthening the radiation safety infrastructure at institutional and national levels. The first PGEC was held in Argentina, in 1981. Today it is offered in Arabic, English, French, Portuguese, Russian and Spanish.

A side event titled 'Vision for the Future' was held on the margins of the IAEA General Conference to mark the 100th iteration of the PGEC. Former PGEC graduates shared their experiences to build greater awareness of the course. Since its establishment in

“In Latin America, 22 radio-oncologists from 15 Latin America countries have graduated from the Master's in Advanced Radiotherapy since 2018.”

1981, over 1800 young professionals from 120 countries have taken part in PGECs, benefitting their professional careers, and contributing significantly to a strengthened national radiation safety infrastructure.

In Taiyuan, China, 24 participants from 14 different countries of the Asia and the Pacific region attended a three-week regional School of Radiation Emergency Management, in October. The participants were trained to develop and manage sustainable emergency preparedness and response programmes, based mainly on IAEA safety standards, technical guidelines, tools and training material. The event provided the participants with a comprehensive understanding of the nuclear and radiological emergency preparedness and response framework.

Legislative and drafting assistance

In 2019, the Agency continued to provide legislative assistance to Member States within the framework of project INT0096 'Establishing and Enhancing National Legal Frameworks for the Safe, Secure and Peaceful Use of Nuclear Energy and Ionizing Radiation'. The ninth session of the Nuclear Law Institute was conducted in October in Vienna, Austria. The training was attended by 65 participants from 56 Member States from Africa, Asia and the Pacific, Europe and Latin America and the Caribbean, and enabled participants to acquire a solid understanding of nuclear law and to develop the necessary skills to draft, amend or review national nuclear legislation. The project also supported the participation of several fellows in the Nuclear Energy Agency (OECD/NEA) International School of Nuclear Law held in August-September in Montpellier, France. Other activities implemented under the project include two Regional Workshops on Nuclear Law conducted for the Asia and the Pacific Region in Jakarta, Indonesia, in August, and in Vienna, Austria, in December, which were attended by over 60 participants from 27 Member States of the region. A meeting for legal advisers of regulatory bodies was organized for the first time in July, which supported the identification of needs in Member States and of ways to expand training opportunities and reference material for the benefit of the exercise of the legal support function in regulatory bodies.

During 2019 the Agency also provided bilateral assistance to 17 Member States from different regions through written comments as well as through workshops, missions and meetings to raise awareness, and provide advice and training on developing and revising national legislation. National workshops on different aspects of nuclear law and the related international legal instruments were held in Bolivia, Costa Rica, Egypt, Kuwait, Philippines, Rwanda and Senegal. A side event held on the margins of the 63rd regular session of the General Conference highlighted the benefits and impact of the Agency's legislative assistance for the enhancement of national nuclear legal frameworks in Bolivia, Mauritius, Niger, Philippines and Serbia.

The Agency also continued to provide assistance to Member States in drafting regulations. During the Fourth School for Drafting Regulations on Radiation Safety and Security in Asia and the Pacific held for three weeks at the IAEA in July 2019, 15 participants from Lao People's Democratic Republic, Mongolia, Papua New Guinea, the Philippines, Viet Nam and the territories under the jurisdiction of the Palestinian Authority were provided with information on the requirements of the latest IAEA Safety Standards. The School helped participants to identify gaps in their regulatory framework and subsequently to draft new,

PGECs in 2019

Africa: 35 young professionals were trained as radiation protection officers at PGECs hosted in Algeria and Ghana.

Asia and the Pacific: 31 trainees participated in PGECs in 2019. 388 trainees in total have graduated in the region since 2001.

Europe: 19 participants from 16 countries attended a PGEC in Greece, which has hosted 6 PGECs in Europe in the English language since 2003, and trained over 100 students. Training is also offered in Belarus in Russian.

Latin America and the Caribbean: 20 participants from 12 countries attended the PGEC in Spanish (Argentina). 43 PGEC courses have been organized in the region to date, with over 600 participants.

or revise existing regulations in accordance with IAEA safety requirements, while taking into account national frameworks and priorities.

Building awareness of the TC programme¹³

TC outreach in 2019

178 IAEA web articles on technical cooperation

5500 @IAEATC Twitter followers (22% increase), over 460 @IAEATC tweets

1400 @iaeapact Twitter followers (23% increase), 79 tweets (since June)

1700 LinkedIn TC Alumni Group members

Outreach to Member States, current and potential partners, donors and the international development community is a key area of activity for the Agency. Throughout 2019, extensive efforts were continued to build awareness of the TC programme at all levels, through participation in relevant conferences, attendance at events focused on special topics, and concerted outreach efforts online and via social media.

Outreach to the diplomatic community continued, with the annual Seminar on Technical Cooperation for Diplomats in Vienna, attended by diplomats from 35 Permanent Missions. Representatives from eleven Permanent Missions attended the first seminar on technical cooperation for diplomats held in Berlin.

Five side events related to technical cooperation were organized in September on the margins of the IAEA General Conference. A panel discussion 'Youth in Nuclear: Engaging the Next Generation of Leaders' noted that over 60% of the population in Africa is under 25, and the continent has the world's largest youth population relative to its size. During the panel discussion, participants examined how to develop young people's skills and knowledge to reap the benefits of nuclear science. They discussed the important role of policymakers, established professionals and organizations in raising interest in the nuclear field and providing opportunities to build knowledge, skills and networks.



Youth in Nuclear' included representatives from African Young Generation in Nuclear, the Next Einstein Forum, one IAEA project counterpart and one fellow, as well as the United Nations-Nuclear Young Generation. (Photo: O. Yusuf/IAEA)

¹³ This section responds to section A.5, operative paragraph 7, of resolution GC(63)/RES/9 on strengthening public communication.



Over 400 participants attended the Symposium on Nuclear Applications in Bogota, Colombia, presenting results and discussing the way forward to leverage Colombia's potential in nuclear science and technology for socioeconomic development. (Photo: H. Olaya/ Colombian Geological Service)

Another side event, on cultural heritage preservation, showcased over ten years of IAEA capacity-building in radiation processing, specifically the disinfection of cultural heritage artefacts by irradiation, which replaces traditional chemical or physical methods. Success stories from Brazil, Croatia, France and Indonesia were presented to over 70 attendees. Speakers noted the versatility of radiation technology in conservation and preservation, and drew attention to ongoing IAEA-supported research in this field.

Further side events were held on the 100th iteration of the PGEC in Radiation Protection and the Safety of Radiation Sources; IAEA Support to Environmental Remediation Projects; and on the new edition of InTouch+.

The Agency also attended relevant international events to raise awareness of its contribution to development. These included the Global Conference on Strengthening Synergies between the Paris Agreement and the 2030 Agenda for Sustainable Development in Denmark in April, and the Asian Development Bank's Rural Development and Food Security Forum 2019 in the Philippines in October, as well as high-level UN events. In addition, the Agency participated in high-level health conferences such as the World Health Summit in Berlin, the 2019 World Cancer Leaders' Summit in Nur-Sultan, and the World Health Organization Global Meeting to Accelerate Progress on SDG Target 3.4 on Noncommunicable Diseases and Mental Health in Muscat, in order to highlight its work to advance access to quality radiation medicine services in the context of comprehensive cancer control. The Agency also took part in the UN Interagency Task Force on the Prevention and Control of Non-Communicable Diseases, a global initiative which monitors the joint efforts of UN agencies and partners to support governments to meet high-level commitments in response to the global non-communicable disease epidemic.

A joint event organized by Women in Nuclear IAEA and PACT on 'Women in Nuclear and Global Action Against Cancer' in September highlighted the inequalities cancer patients face and, in particular, women with breast and cervical cancers living in developing countries.

In October, the Colombian Geological Service, in cooperation with the Ministry of Mines and Energy and the IAEA, organized a Symposium on Nuclear Applications under the motto 'Atoms4Colombia'. The event was attended by over 400 participants from more than 20 organizations, including universities, research institutions, hospitals, ministries and regional authorities, and provided an opportunity for project counterparts to showcase their work and achievements in the many areas where nuclear sciences and applications benefit the socioeconomic development of the country. The Symposium included a panel discussion on gender, which led to the establishment of a forum to explore persistent obstacles to the attainment of greater gender parity in the nuclear field. The Symposium

"A joint event organized by Women in Nuclear IAEA and PACT on 'Women in Nuclear and Global Action Against Cancer' in September highlighted the inequalities cancer patients face and, in particular, women with breast and cervical cancers living in developing countries."

was supported under the national project on capacity-building, COL0014, 'Improving Existing Capabilities to Provide High Quality and Internationally Recognized Nuclear Analytical Services'.

The Agency attended the 23rd International Exhibition of the Energy Sector, 'The Future of Energy', in November 2019 in Veracruz, Mexico, and participated in the panel 'Support of Mexican technology and science to the energy sector'. Information was shared on the IAEA mandate and the role of the technical cooperation programme as the main mechanism for providing technical support to Member States to achieve their development goals. The Agency also provided information on the support provided to Mexico through national and regional technical cooperation projects in the areas of energy, and in support of Mexican science and technology.

In November, the Agency and all 12 counterparts of project RLA1014, 'Advancing Non-Destructive Testing Technologies for the Inspection of Civil and Industrial Structures (ARCAL CLIX)' participated in the VII Pan-American Conference on Nondestructive Testing to raise awareness of the work being done in the region through the IAEA and ARCAL regarding capacity building in the use of these techniques for industrial and civil structures applications.



Agency participation at the VII Pan-American Conference on Nondestructive Testing. (Photo: E. Robles/National Institute for Nuclear Research)

A.2. BUILDING A MORE EFFICIENT, MORE EFFECTIVE TECHNICAL COOPERATION PROGRAMME¹⁴

Revised Supplementary Agreements, Country Programme Frameworks and UN Development Assistance Frameworks¹⁵

By the close of 2019, 25 countries had signed Country Programme Frameworks (CPFs), bringing the total number of valid CPFs to 110, an increase of 10 per cent since 2018. Of the 25 CPFs signed in 2019, 22 were prepared in line with a new format that contains a more concise and focused medium-term programme plan and that simplifies the establishment of clear linkages with national development priorities and with the SDGs.

Revised Supplementary Agreements Concerning the Provision of Technical Assistance by the International Atomic Energy Agency (RSAs) govern the provision of technical assistance by the Agency. The agreements for Eritrea, Guyana, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago entered into force in 2019, bringing the total number of RSAs to 141.¹⁶

¹⁴ Section A.2. responds to section A.3, operative paragraph 1, of resolution GC(63)/RES/9 on strengthening TC activities, including the provision of sufficient resources, based on Member States' needs and priorities, and ensuring that the components of TC projects are readily available.

¹⁵ This section responds to section A.5, operative paragraph 1, of resolution GC(63)/RES/9 on strengthening strategic partnerships in implementing the 2030 Agenda.

¹⁶ This paragraph responds to section A.1, operative paragraph 2, of resolution GC(63)/RES/9 on RSAs.

The United Nations' common programming instrument, the United Nations Development Assistance Framework (UNDAF) was relaunched in 2019 with new guidance under the name United Nations Sustainable Development Cooperation Framework (Cooperation Framework). It aims to ensure that the UN system is better positioned to deliver on the 2030 Agenda and to support partner governments to achieve their national development goals and priorities. The Agency co-signed one Cooperation Framework in 2019, with Sierra Leone, bringing the total number of valid UNDAFs and Cooperation Frameworks co-signed by the Agency to 53.

CPFs signed in 2019	
Afghanistan	Libya
Angola	Lithuania
Belize	Mozambique
Brazil	Namibia
Cameroon	North Macedonia
Dominica	Pakistan
El Salvador	Romania
Eritrea	Sierra Leone
Eswatini	South Africa
Guyana	Sri Lanka
Kuwait	Syrian Arab Republic
Latvia	Uganda
Liberia	

Maximizing programme impact through strategic partnerships¹⁷

The Agency works in close partnership with Member States, UN agencies, national institutes and civil society in order to maximize the contribution of nuclear science and technology to the achievement of development priorities. The goal is to add value to Agency activities, and to take advantage of synergies to optimize the impact of Agency support. This approach also contributes to the achievement of SDG 17, 'Strengthen the means of implementation and revitalize the global partnership for sustainable development'. Twelve new technical cooperation partnerships were concluded in 2019, bringing the total of valid agreements to 66.

The Technical Cooperation Partnership Review and Resource Mobilization Committee remained the central mechanism for the development of Departmental partnerships in 2019, guaranteeing the implementation of the Strategic Guidelines on Partnerships and Resource Mobilization (GOV/2015/35) and promoting coordination, transparency and accountability. A new monitoring framework for partnerships was launched in the second half of the year to better assess their contribution to the work of the TC programme. A training on partnerships and resource mobilization for TC staff was also conducted in 2019 with the aim of providing an overview of the current focus on SDG 17, key principles behind partnerships and resource mobilization including the importance of data and quality reporting, and step by step guidance on partnerships and resource mobilization engagement.

The Agency reached agreement with the European Union on a new €2.8 million Delegation Agreement under the framework of the Instrument for Nuclear Safety Cooperation, €1.2 million of which was assigned to the technical cooperation programme. This builds on the existing good collaboration with the European Commission. The implementation of a

“The Agency reached agreement with the European Union on a new €2.8 million Delegation Agreement under the framework of the Instrument for Nuclear Safety Cooperation, €1.2 million of which was assigned to the technical cooperation programme.”

¹⁷ This section responds to section A.5, operative paragraph 2, of resolution GC(63)/RES/9 on consultations and interactions with interested States, the UN system, multilateral financial institutions, regional development bodies and other relevant intergovernmental and non-governmental bodies; and to section A.5, operative paragraph 3 on participation and contribution with respect to South–South and triangular cooperation; and operative paragraph 5 on developing and facilitating cost sharing, outsourcing and other forms of partnership in development.

contribution of €3.5 million, provided to the Agency through another Delegation Agreement which was signed with the European Commission in 2016, will run until the end of 2020.

In September 2019, the Agency signed Practical Arrangements on enhancing technical cooperation among developing countries and strengthening South-South cooperation with the Ministry of Science and Technology of Viet Nam and the Ministry of Mines and Energy of the Kingdom of Cambodia and another with the Ministry of Science and Technology of Viet Nam and the Ministry of Science and Technology of the Lao People's Democratic Republic. The cooperation includes the provision by Viet Nam – with Agency support – of short- and long-term education and training on radiation applications in food and agriculture, industry and non-destructive testing, radiation and nuclear safety, radioactive waste management, research reactor applications, regulatory infrastructure, radiological emergency preparedness and response, radiation processing, radiation medicine, and marine and terrestrial environmental monitoring and management.

In the area of cancer, new partnerships were established with the Islamic Development Bank and the St. Jude Children's Research Hospital. Relationships with existing partners from Member States and international financing institutions, the private sector, foundations and civil society organizations were fostered to create training opportunities for health professionals and raise funds to support cancer control activities. Also, in the area of cancer control, in 2019 the Russian Federation decided to prolong its support to the Agency for the training of cancer specialists up to 2023 under the technical cooperation programme, through PACT. The agreement builds on the success of the extensive training programmes for Russian speaking cancer specialists over the past seven years.¹⁸

In 2019, as a follow-up to the Practical Arrangements signed between the Agency and the African Union Commission (AUC) for the safe, secure and peaceful use of nuclear technologies for sustainable development in Africa, the Division for Africa, in collaboration with the AUC Department of Human Resources, Science and Technology, organized a workshop in Kigali, Rwanda, on operationalizing the AUC/IAEA Practical Arrangements to promote the peaceful use of nuclear technology for sustainable development.

The Agency also signed Practical Arrangements with the African Commission on Nuclear Energy in 2019. These Arrangements establish a framework for non-exclusive cooperation between the parties, with the aim of providing support to African IAEA Member States that are States Parties to the Pelindaba Treaty. This non-exclusive cooperation covers the peaceful use of nuclear science and technology for development, nuclear safety and security, and safeguards. An action plan is being developed within the framework of these Practical Arrangements.

In 2019, the Action Plan for the Memorandum of Understanding signed in 2018 between the Government of Portugal and the Agency came into effect. Under this Action Plan, Portugal is hosting, free of charge, fellows and scientific visitors at Portuguese institutions up until 2023. In addition, students from countries in which Portuguese is the official language will receive a 50% reduction in tuition fees for master's degrees in physics, medical physics and radiological protection.

In 2019, on the margins of the 63rd IAEA General Conference, the Ambassadors/Permanent Representatives of Angola, Brazil and Mozambique signed an Action Plan to promote Technical

“In the area of cancer, new partnerships were established with the Islamic Development Bank and the St. Jude Children's Research Hospital.”



The Ambassadors of Angola, Brazil and Mozambique mark the signature of the Action Plan to implement South-South cooperation within the scope of the IAEA technical cooperation programme. (Photo: M. Loidolt/IAEA)

¹⁸ This paragraph responds to section B, operative paragraph 5, of resolution GC(63)/RES/9 on advocating and building support for the Agency's work on cancer control.

Technical cooperation partnerships signed by the Agency in 2019	
Partner (Memorandum of Understanding)	Area of cooperation
Islamic Development Bank	Cancer partnership initiative for breast and cervical cancer control in low and middle income countries.
Partner (Practical Arrangements)	
Texas A&M Engineering Experiment Station, on behalf of its Nuclear Power Institute	Capacity building in nuclear energy, safety and security
University of the South Pacific	Education and training in the peaceful uses of nuclear applications
Italian Society for Non-Destructive Testing Monitoring Diagnostics	Application of non-destructive testing
Ministry of Science and Technology of Viet Nam and the Ministry of Mines and Energy of Cambodia	Strengthening South–South and triangular cooperation for the implementation of the Agency's technical cooperation programme
Ministry of Science and Technology of the Lao People's Democratic Republic and the Ministry of Science and Technology of Viet Nam	Strengthening South–South and triangular cooperation for the implementation of the Agency's technical cooperation programme
Kuwait Institute for Scientific Research	Marine environmental monitoring and protection
Association of Southeast Asian Nations	Nuclear science and technology and applications
St. Jude Children's Research Hospital	Combatting childhood cancer in developing countries
Partner (Contribution Agreement)	
European Commission	Nuclear safety
Partner (Agreement)	
State Atomic Energy Corporation "Rosatom"	Capacity building
National Office for Food Safety (Morocco)	Procurement of irradiator

Cooperation among Developing Countries (TCDC) between Portuguese-speaking countries. The signing of the Action Plan aims to strengthen collaboration between these countries in priority areas to help them maximize the peaceful use of nuclear technology for development. It defines specific activities under national and regional projects to create synergies and links that will facilitate the participation of counterpart institutes.

In September, the Agency signed Practical Arrangements with the Italian Society for Non-Destructive Testing Monitoring Diagnostics (AIPnD) to broaden the scope of cooperation in regard to capacity building efforts within Member States. Under the terms of the new Practical Arrangements, the AIPnD will make non-destructive testing experts and lecturers available to the Agency in order to strengthen the Agency's capacity building efforts, and will facilitate both short- and long-term training in Italy. The two organizations have also agreed to engage in an ongoing exchange of educational material and best practices. In 2019, collaboration with Latin American and Caribbean Member States focused on the national certification processes.



Practical Arrangements were signed with the Italian Society for Non-Destructive Testing Monitoring Diagnostics in September 2019. (Photo: O. Yusuf/IAEA)

Female participation in the TC programme¹⁹

The Agency strongly encourages the expansion of female participation in the TC programme, and Member States are encouraged to nominate female NLOs, meeting and workshop participants, fellows and scientific visitors, and counterparts.

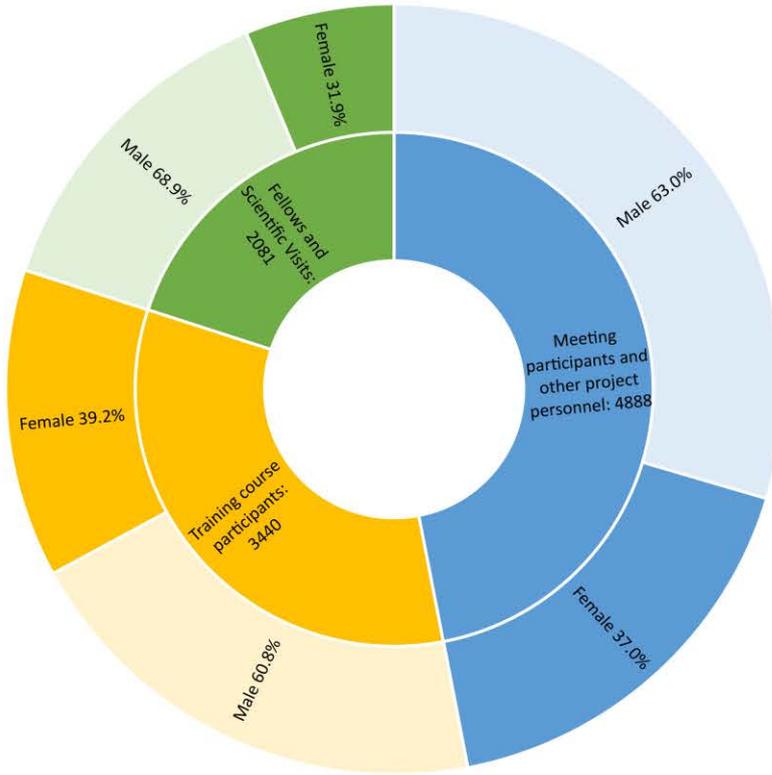
Several TC projects are specifically targeted at women, focusing on women's health, and women farmers. In addition, every TC project design must consider gender as a cross-cutting issue, and the team working on the design of the project is expected to describe, where relevant, any efforts to assess the different implications for women and men of any planned action, including with regard to legislation, policies or programmes, and to indicate if a gender analysis has been conducted and whether the project is linked to any national, thematic or institutional gender strategy.

In 2019, 3804 women from all regions participated in the TC programme as fellows, scientific visitors, meeting and training course participants. 2014 women participated as counterparts, international experts and lecturers.

Within the Department of Technical Cooperation, women make up 70% of the staff overall, with 52% of professional and higher categories staff. At Director level, 50% of staff are female. Of the 21 members of the Standing Advisory Group on Technical Assistance and Cooperation, eight are women.

“In 2019, 3804 women from all regions participated in the TC programme as fellows, scientific visitors, meeting and training course participants. 2014 women participated as counterparts, international experts and lecturers.”

¹⁹ This section responds to section A.2, operative paragraph 3, of resolution GC(63)/RES/9 on advancing gender mainstreaming and gender balance in the TC programme.



■ Fellows and Scientific Visits: 2081 ■ Meeting participants and other project personnel: 4888 ■ Training course participants: 3440

Figure 2: Male/female participation in the TC programme.



Figure 3: Percentage of male and female NLOs by region.



Young professional women at ARCAL's workshop in Cuba, which aimed at providing necessary leadership skills to scientists in nuclear-related areas. (Photo: Agency for Nuclear Energy and Advanced Technologies/Cuba)

In 2019, at the request of Member States, two ARCAL workshops were organized to promote nuclear applications amongst young leaders in the nuclear field, focusing on young women and with approximately 80% female participation. The workshops covered technical issues but also focused on leadership and other soft skills of paramount importance for future leaders to succeed in their technical fields. The workshops encouraged networking, and were a catalyst for the creation of new national chapters of Women in Nuclear in the region: five new countries (Chile, Colombia, Costa Rica, Ecuador and Uruguay) have taken steps to consolidate the establishment of their national chapters. The ARCAL National Coordinators subsequently agreed to continue the annual organization of workshops focusing on young professional leaders, especially women, in areas related to nuclear and isotopic techniques. In addition, they agreed to present an unfunded project to support the creation of the Women in Nuclear-ARCAL chapter as a regional chapter.

During the 20th Meeting of ARCAL's Technical Coordination Board, all National Coordinators agreed to continue with the annual organization of such workshops focusing on young professional leaders, especially women, in areas related to nuclear and isotopic techniques. Moreover, they agreed to present a project without IAEA financing to support the creation of the Women in Nuclear-ARCAL chapter as a regional chapter, giving continuity to the actions already undertaken in the region related to gender mainstreaming.

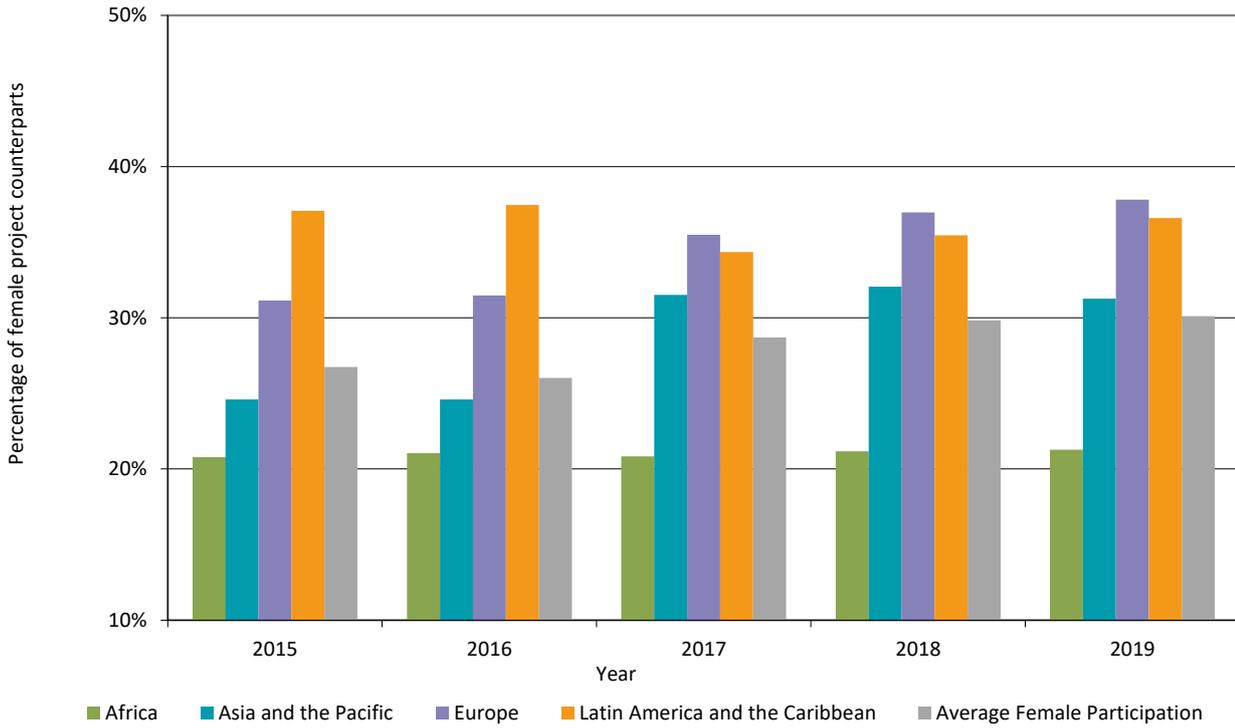


Figure 4: Female project counterparts by region, 2015–2019.

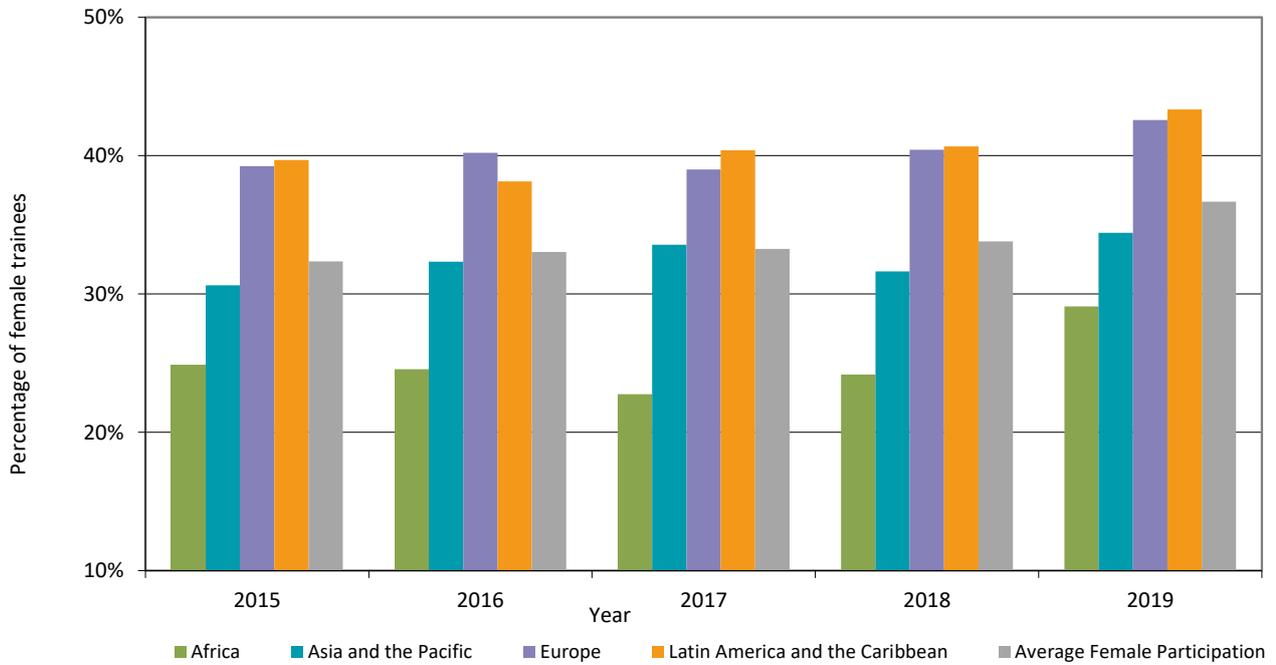


Figure 5: Female participation in training as fellows, scientific visitors, training course participants, meeting participants and other project personnel, 2015–2019.

Ensuring the continual improvement of the TC programme²⁰

The quality assurance undertaken at every phase of the TC programme cycle is an important cornerstone for the continual improvement of the TC programme. The objective is to increase the efficiency, effectiveness and results orientation of TC programmes and projects during planning, implementation and review.

The quality assurance for the design phase of the 2020–2021 TC programme cycle was based on the TC Quality Criteria and entailed the assessment of two aspects of project design, namely the extent to which the project design document complies with the TC central criterion²¹, and the extent to which the project design complies with the logical framework approach. A two-step mechanism was applied, initially providing sound and constructive feedback to project teams for the improvement of 613 draft project designs, and subsequently conducting a consolidated quality review of the 591 final project designs. The quality assurance activities for the 2020–2021 TC programme cycle were based on country and regional portfolios to further support a programmatic approach to technical cooperation work in each country, and to better identify overlaps, discrepancies and potential synergies between projects. The outcome of the quality review showed further improvements in project quality.

Quality assurance during project implementation is anchored in TC Reports, the electronic platform for submission of mandatory annual Project Progress Assessment Reports (PPARs). The submission rate for PPARs has steadily increased since the introduction of the TC Reports platform, with 80% of active TC projects submitting reports during 2019. The TC Reports platform has become a key tool for more effective reporting, monitoring and management of the implementation progress of TC projects and has significantly increased interaction and communication with Member States.

Close to 50 workshops, training events and programme briefings, ranging from 1 to 5 days, were conducted on the results based approach to the TC programme. These were organized both in-house and in Member States and included TC Orientation Workshops, training in the use of the logical framework approach for the design of new projects, country and regional project design workshops, and specific discussion groups on relevant issues. The latter included a new and dedicated peer knowledge sharing forum (Programme Management Officer Roundtable) to exchange experiences, knowledge and good practices and facilitate effective and efficient programme and project management. An e-learning course on designing high quality IAEA technical cooperation projects is available to both IAEA staff and external counterparts. Several hundred persons took the course during the programme design phase over the last two years. Targeted training in monitoring and evaluation was included, and a webinar on PPAR reporting was conducted.

The Agency is making progress in the development of an evaluation framework to demonstrate the socioeconomic impact of some thematic areas of technical cooperation projects and programmes. Following an expert meeting in 2018 on impact assessment methodology, several studies are now underway to explore approaches to assess the socioeconomic impact of technical cooperation in some thematic areas over a period of time.

²⁰ This section responds to section A.2, operative paragraph 11, of resolution GC(63)/RES/9 on PCMF implementation, and making it simpler and user-friendly for effective use; section A.3, operative paragraph 4, on optimizing the quality, the number and the impact of TC projects; section A.3, operative paragraph 5, on providing Member States with information on project development according to the LFA; section A.3, operative paragraph 6, on submission and guidance of reporting; section A.3, operative paragraph 7, on the results of efforts to implement outcome monitoring; section A.3, paragraph 8, on the two-step mechanism in monitoring the quality of TC projects; and section A.3, paragraph 9, on enhancing adherence to the central criterion and all the TC requirements.

²¹ To meet the central criterion, a project must either relate clearly to an area that is a prerequisite for use of nuclear technologies and that has a good chance of achieving the expected outcomes, or address an area where there is a national programme enjoying strong government commitment with evidence of significant financial support, and where nuclear techniques can play a fundamental role for the success of the project.

“The Agency is making progress in the development of an evaluation framework to demonstrate the socioeconomic impact of some thematic areas of technical cooperation projects and programmes.”

Throughout 2019, the Department of TC has implemented a number of improvements to the tools, processes and guidance for the management of the TC programme. These included further strengthening a results based management approach into Country Programme Frameworks and further promoting the incorporation of gender and sustainability aspects at programme and project level planning. Additionally, risk management practices throughout the project life cycle and the documentation and usage of lessons learned were continuously emphasized as key aspects of results based management at the project level. During project implementation, the annual Project Progress Assessment Report (PPAR) also has specific sections on risk management and lessons learned. As a result, more than 60 recommendations from evaluations and audits conducted by the Office of Internal Oversight Services (OIOS) were either closed or considered implemented, demonstrating the high importance that TC attaches to incorporating the findings and recommendations of OIOS audits and evaluations into the process of continually improving the TC programme. The Department of Technical Cooperation has worked closely with OIOS on developing comprehensive action plans to address TC-related recommendations from new OIOS audits and evaluations conducted in 2019. These were prepared in close interaction with OIOS, particularly with regard to identifying appropriate means of verification and to consolidating the individual recommendations into thematic areas to ensure their most effective and efficient implementation.²²

²² This paragraph responds to section A.3, operative paragraph 11, of resolution GC(63)/RES/9 on OIOS evaluation of projects.

B. TC Programme Resources and Delivery



B. TC Programme Resources and Delivery

B.1. FINANCIAL OVERVIEW

Resources for the technical cooperation programme²³

At the end of 2019, €82.2 million of the €86.2 million target for the 2019 Technical Cooperation Fund (TCF) had been pledged and €81.0 million in payments had been received. Total TCF resources including National Participation Costs (NPCs), assessed programme costs (APCs) arrears, and miscellaneous income amounted to €82.0 million (€81.0 million TCF, €0.4 million NPCs, €0.1 million APC, and €0.5 million miscellaneous income.). New extrabudgetary resources for 2019 came to €12.3 million and in-kind contributions amounted to €0.3 million.

The rate of attainment on pledges, as at 31 December 2019, was 95.4% and the rate of attainment on payments on the same date was 94.0% (Fig.5). One hundred and twenty-eight Member States, including 18 LDCs, paid their TCF target in full or partially. Total payments received in 2019 include €24 600 either of deferred or of additional payments by 9 Member States. Excluding these payments, the 2019 rate of attainment on payments would have still been 94.0%.

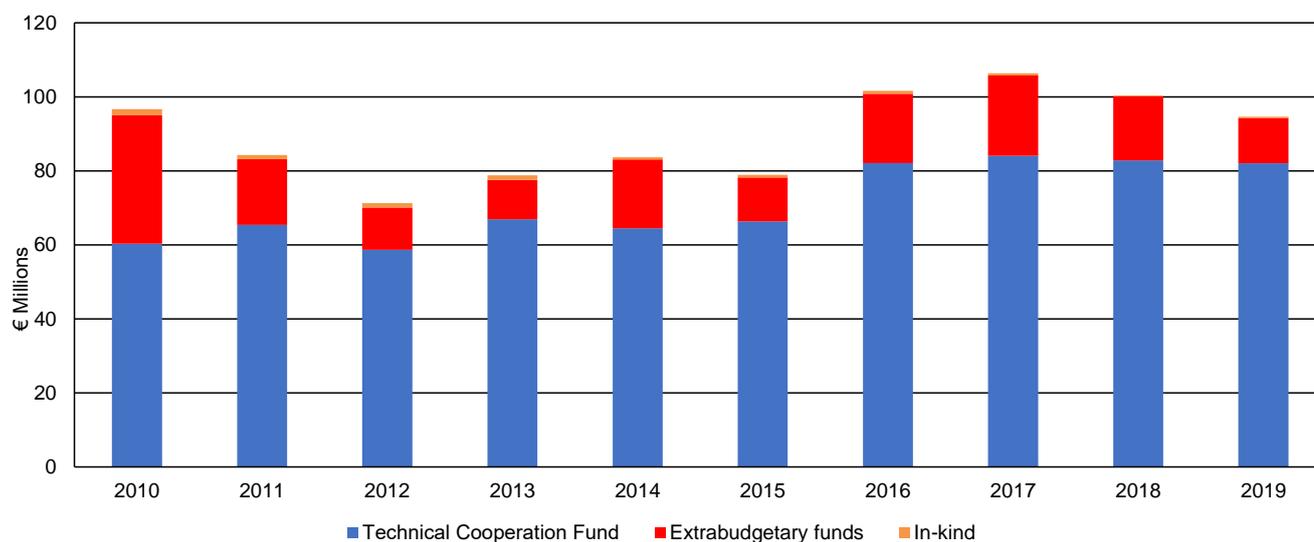


Figure 6: Trends in TC programme resources, 2010–2019.

²³ This section responds to section A.4, operative paragraph 2, of resolution GC(63)/RES/9 on the payment of TCF contributions and NPCs, and payment of APC arrears; and to section A.4, operative paragraph 5, on timely payments to the TCF.

Table 1: TC programme resources in 2019

2019 target for voluntary contributions to the TCF	€86.2 million
Technical Cooperation Fund, NPC, APC, miscellaneous income	€82.0 million
Extrabudgetary resources ²⁴	€12.3 million
In-kind contributions	€0.3 million
Total new resources for the TC programme	€94.6 million

Table 2: Payment of National Participation Costs (NPCs) and assessed programme cost (APC) arrears

	Received in 2019	Outstanding payments at end 2019
NPCs	€0.4 million	€0.5 million
APCs	€0.1 million	€0.8 million

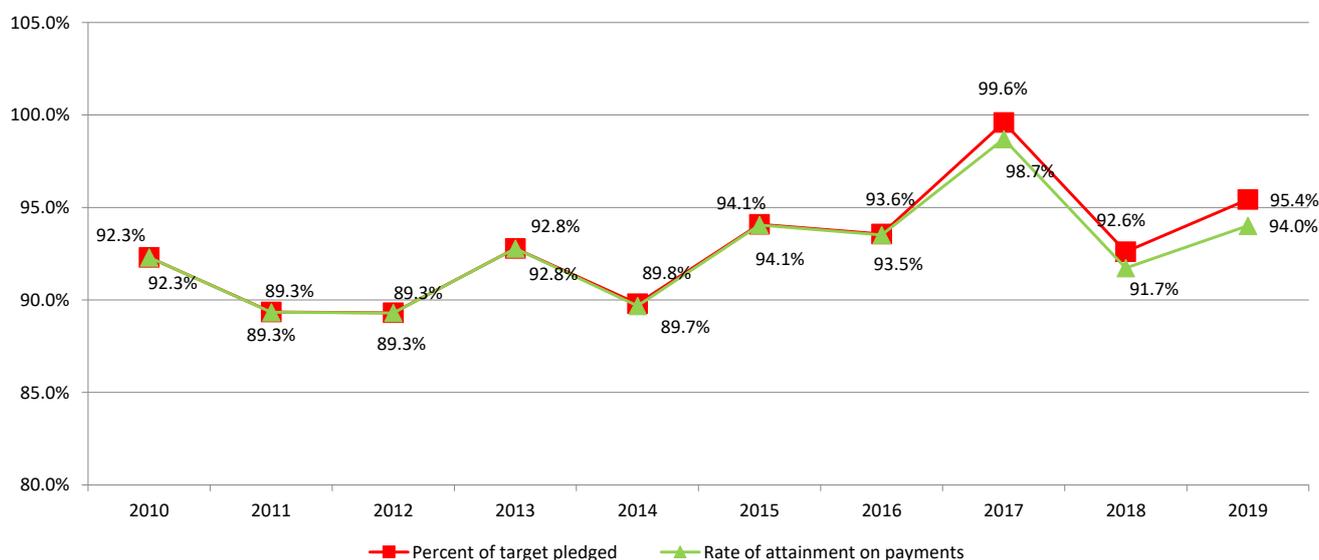


Figure 7: Trends in the Rate of Attainment, 2010–2019.

Extrabudgetary and in-kind contributions²⁵

Extrabudgetary contributions from all sources in 2019 (donor countries, international and other organizations, government cost sharing) accounted for €12.3 million. The breakdown of the €12.3 million is as follows: €4.3 million funding for activities where the donor is the recipient (commonly referred to as Government Cost Sharing); €8.0 million from donors, of which €5.9 million was received through the Peaceful Uses Initiative mechanism. Twelve African Member States provided extrabudgetary contributions amounting to €391 521 for regional technical cooperation projects through the AFRA Fund. More detail is contained in Table 3 (extrabudgetary contributions by donor), Table 4 (government cost sharing) and Table 5 (contributions to PACT). In-kind contributions accounted for €0.3 million in 2019.

²⁴ Please refer to Table A.5 of the Supplement to this report for details.

²⁵ This section responds to section A.4, operative paragraph 8, of resolution GC(63)/RES/9 on seeking resources to implement footnote-a/ projects; section A.4, operative paragraph 9, on voluntary contributions and the implementation of footnote-a/ projects; section A.4, operative paragraph 10, on extrabudgetary contributions, including the PUI; and section B, operative paragraph 16, on strengthening PACT's programme strategy and planning as well as strategy for mobilization of additional resources.

Table 3: Extrabudgetary contributions allotted to TC projects in 2019, by donor (in euros)

Belgium	150 000	Russian Federation	303 285
Chile	9000	Spain	200 000
China	52 085	Sri Lanka	5000
Czech Republic	175 400	Sweden	186 567
France	70 000	Switzerland	100 000
Indonesia	44 572	United States of America	3 327 119
Israel	20 000	AFRA Fund	391 521
Japan	960 250	European Commission	131 136
Korea, Republic of	259 478	Korea Nuclear Association for International Cooperation	172 255
Malaysia	10 000	OPEC Fund for International Development	357 446
Netherlands	126 260	Total	7 055 810
Philippines	4435		

Table 4: Funding where the donor is the recipient (Government cost sharing) allotted to TC projects in 2019 (in euros)

Botswana	35 000	Pakistan	5000
Costa Rica	90 340	Qatar	124 985
Ghana	44 950	Saudi Arabia	45 000
Indonesia	128 149	Serbia	230 000
Lithuania	10 000	Thailand	112 568
Malta	150 000	Uzbekistan	433 500
Republic of Moldova	500 000	Total	4 309 492
Niger	2 400 000		

Table 5: Extrabudgetary contributions to PACT, 2019²⁶

Donor	Amount (euros)
Russian Federation	186 348
Monaco	40 000
Korea, Republic of	18 080
United States of America	676 360
Total	920 788

²⁶ In addition to EUR 920 788, EUR 3.1 million (reported under Table 3 and Table 4) have been received as a result of PACT resource mobilization efforts benefiting a range of TC projects. Funds were mobilized from the United States, as well as from Niger through a partnership arrangement between the country and the IsDB.

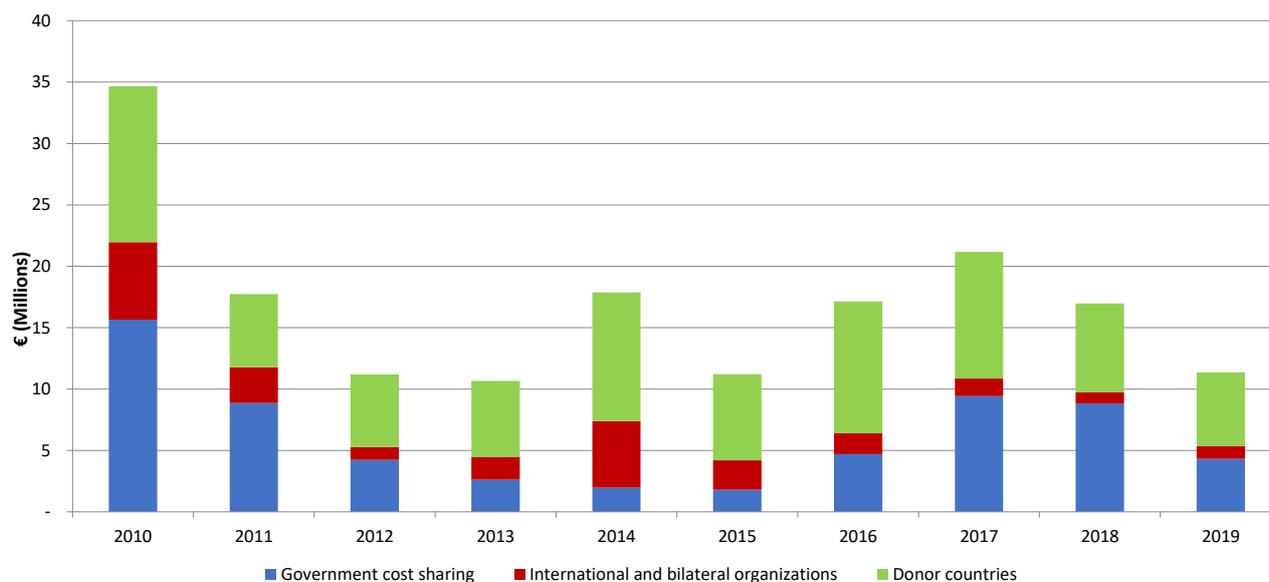


Figure 8: Trends in extrabudgetary contributions by donor type, excluding contributions to PACT, 2010–2019.

B.2. DELIVERING THE TECHNICAL COOPERATION PROGRAMME

Financial implementation

TC programme delivery is expressed in both financial and non-financial terms. Financial delivery is articulated in terms of actuals²⁷ and encumbrances. Non-financial delivery (i.e. outputs) can be expressed numerically in terms of, for example, experts deployed, training courses conducted, and purchase orders obligated.

Financial implementation for the TCF, measured against the budget for 2019 as at 31 December 2019, reached 89.1% (Table 6).

Table 6: TCF financial indicators for 2017, 2018 and 2019

Indicator	2017	2018	2019
Budget allotment at year end ²⁸	€106 136 533	€106 612 040	€123 376 365
Encumbrances + actuals	€91 570 710	€91 377 251	€109 937 361
Implementation rate	86.3%	85.7%	89.1%

Unallocated balance

At the end of 2019, the unallocated balance²⁹ amounted to €1.7 million. €10.9 million were received as advance payments for the 2020 TCF in 2019. Some €1.6 million of cash is held in non-convertible currencies which cannot be used in the implementation of the TC programme.

²⁷ Terminology has changed with the implementation of the Agency-wide Information System for Programme Support (AIPS/Oracle). Actuals are the equivalent of disbursements.

²⁸ 2019 budget allotment at year end includes carry-over from previous years of €6.8 million, already allotted to projects.

²⁹ Total funds not allocated to TC projects..

Table 7: Comparison of the unallocated balance of the TCF (in euros)

Description	2018	2019
Unallocated balance	-	1 737 654
Advance payment in 2018 and 2019 for TCF for following year	11 928 415	10 899 855
Non-convertible currencies that cannot be utilized	1 503 190	1 625 139
Currencies that are difficult to convert and can only be used slowly	455 225	15 747
Adjusted unallocated balance	13 886 830	14 278 395

Human resources and procurement

Human resource and procurement indicators show the non-financial delivery of the TC programme. Regarding procurement, a total of 2132 purchase orders were issued in 2019, to a value of €51 107 090.

Table 8: Delivery of outputs: non-financial indicators for 2019

Indicator	
Expert and lecturer assignments	3843
Meeting participants and other project personnel	6006
Fellowships and scientific visitors in the field	2081
Training course participants	3440
Regional and interregional training courses	220

Table 9: TC procurement in 2019

Division	Requisitions	Purchase orders issued	Value of Purchase Orders issued
TCAF	762	939	€20 486 435
TCAP	394	429	€9 478 523
TCEU	289	312	€9 195 985
TCLAC	331	452	€11 946 147
PACT	1	-	-
Total	1777	2132	€51 107 090

At the end of 2019, 837 projects were active, and an additional 511 projects were in the process of being closed. During 2019, 178 projects were closed. One project was cancelled in consultation with the relevant Member State.

Programme Reserve projects

TC project UZB2001, 'Building Human Resources Capacities for a First Nuclear Power Plant' was funded from the Programme Reserve in 2019. The amount of €45 301 was spent for the activities of the project.



C. Programme Activities and Achievements in 2019

C. Programme Activities and Achievements in 2019³⁰

C.1. AFRICA

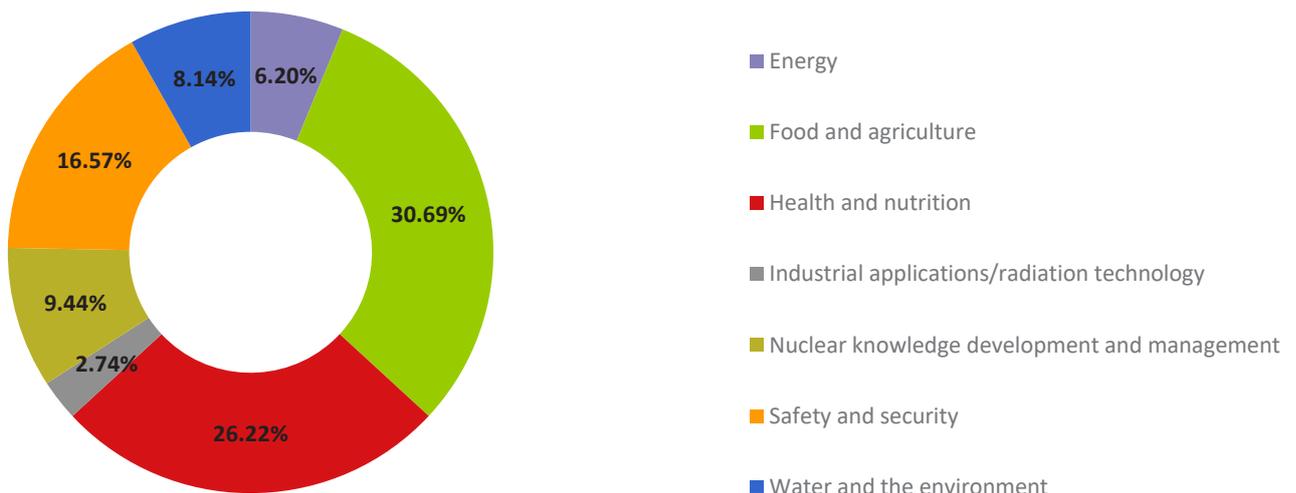
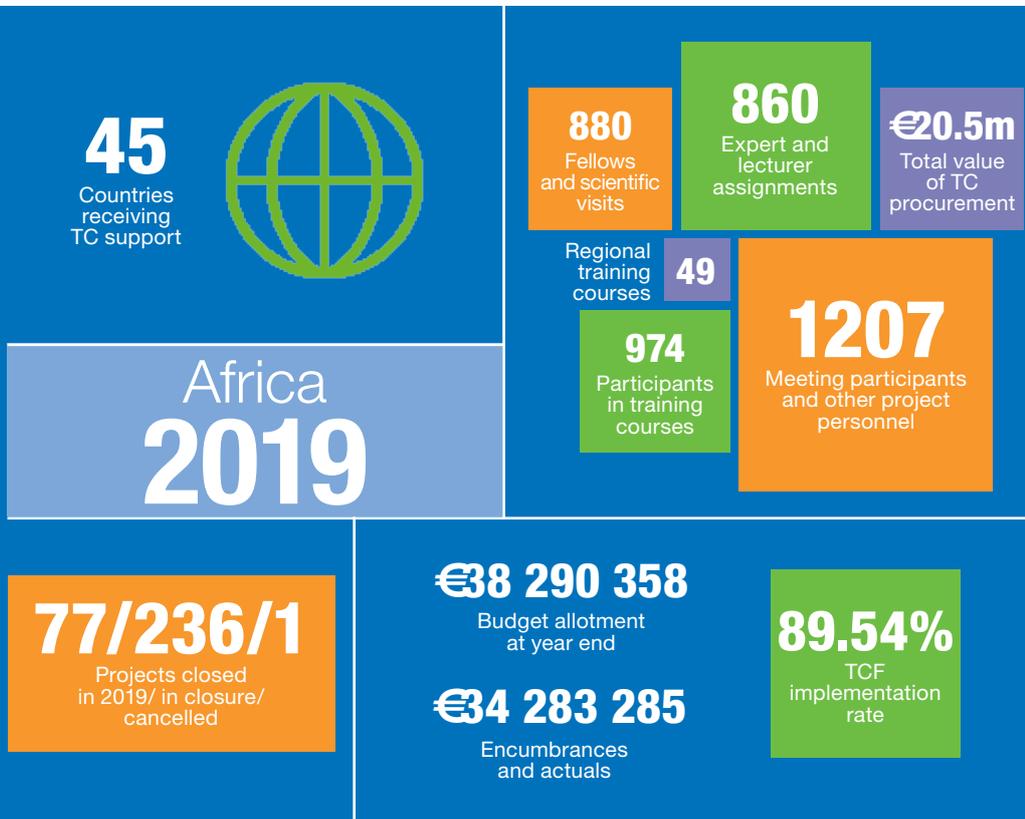


Figure 9: Actuals in the Africa region in 2019 by technical field.

³⁰ Section C responds to section A.1, operative paragraph 3, of resolution GC(63)/RES/9 on assist Member States in the peaceful, safe and secure application of nuclear science and technologies; section A.2, operative paragraph 1, on facilitating and enhancing the transfer of nuclear technology and know-how among Member States; section A.2, operative paragraph 2, on strengthening TC activities through the development of effective, efficient and outcomes oriented programmes; section A.2, operative paragraph 5, on climate change adaptation and mitigation through the use of nuclear techniques; and section A.5, operative paragraph 4, on promoting TC activities supporting the self-reliance, sustainability and further relevance of national nuclear and other entities in Member States, and enhancing regional and interregional cooperation.

Regional highlights in Africa

In 2019, 45 Member States in the Africa region, of which 26 were LDCs, participated in the TC programme through 294 national and 47 regional projects. The programme achieved an implementation rate of 89.5% in the region.

CPFs signed in Africa in 2019

Angola Mozambique

Cameroon Namibia

Eritrea Sierra Leone

Eswatini South Africa

Liberia Uganda

Libya

Eleven Member States successfully developed and signed their Country Programme Frameworks. CPFs for Chad, Côte d'Ivoire, Gabon, Mali, Mauritania, Mauritius, Republic of the Congo and Togo are at an advanced or final stage of preparation, and are planned for signature in 2020.

In 2019, the IAEA co-signed the United Nations Sustainable Development Cooperation Framework 2020–2023 of Sierra Leone.

The IAEA's regional technical cooperation programme in Africa focused on the three major priority areas highlighted in the AFRA Regional Strategic Cooperative Framework 2019–2023 and the RPF for Africa 2019–2023. These are food and agriculture, human health, and radiation and nuclear safety. The development of human resources through education and training formed a major component of technical cooperation assistance provided in 2019, supporting national efforts to build capacities and ensure the availability of skilled staff in African Member States.

In April, NLOs from forty Member States attended the annual NLO meeting, organized by the Agency in collaboration with the Tanzania Atomic Energy Commission. The meeting was opened by the Deputy Minister of Education, Science and Technology of the United Republic of Tanzania. Participants discussed and agreed on strategies and implementable decisions to further enhance the delivery of the technical cooperation programme in Africa.

In February, the Agency participated in the Extraordinary session of the African Commission on Nuclear Energy. Presentations were made by partners to highlight the status of activities already implemented in Africa. Discussions emphasised developing and strengthening specific cooperation between the Agency and the African Commission on Nuclear Energy.

Within the framework of signed Practical Arrangements between China and the Agency, the Director of the Division for Africa visited China on a fact-finding mission in April, where he met counterparts and explored South-South cooperation opportunities within the framework of the TC programme in Africa. During his visit, the Director met IAEA fellows from Africa who were studying in Harbin Engineering University of Engineering, made a presentation on Nuclear Science and Technology for Sustainable Development at Tsinghua University, and explored more training opportunities in Harbin and Tsinghua Universities.

In October, the Agency participated in the Africa Nuclear Business Platform 2019 in Nairobi, Kenya, hosted by the Kenya Nuclear Electricity Board in collaboration with the African Commission on Nuclear Energy. IAEA assistance to countries embarking on a nuclear power programme was highlighted, and the IAEA's Milestones approach was emphasized as a comprehensive phased method to assist countries that are considering or planning their first nuclear power plant.

Project highlights

In 2019, project RAF5078, 'Establishing a Food Safety Network through the Application of Nuclear and Related Technologies, Phase II (AFRA)', focused on building capacities of participating Member States to address food safety concerns, thus supporting food security and, when applicable, access to food export markets. Assistance was mainly provided to enhance control of chemical and microbial hazards, using nuclear, isotopic and complementary techniques, and to strengthen networking among African laboratories. Currently, 21 African Member States have the capabilities to test a range of food hazards



Participants at the Meeting of NLOs in United Republic of Tanzania. (Photo: T. Tshelo/IAEA)

in different food matrices, which has reduced cost of analysis (compared to sending such tests overseas). Ten of the participating Member States have also developed capacities to train food safety technicians and researchers, and two countries (Egypt and South Africa) can produce and provide proficiency testing materials according to ISO17043 accreditation. With IAEA support, African countries are continuing to network on matters of food safety, helping each other to build such capabilities and supporting national and regional public health and consumer protection initiatives.

Long term training leading to qualification in support of cancer therapy was provided to many radiation oncologists, medical physicists, radiation therapy technologists (RTTs) and radiopharmacists through national and regional projects in 2019. Several regional training courses were provided under project RAF6050, 'Improving Access to Quality Cancer Management through Sustainable Capacity Building' in 2019 to improve quality in radiotherapy, focusing on oncology nursing, RTT practices in radiation oncology (in English and in French), and on evidence-based radiotherapy for prostate cancers (in French). In addition, a number of short-term group fellowships were provided to support Member States to upgrade their radiotherapy techniques.

Emergency supplies for animal disease diagnostic were provided to Mozambique in 2019 at the request of the Ministry of Agriculture and Food Security, to assist in the control of outbreaks of animal diseases such as African swine fever, foot-and-mouth disease and Rift Valley fever in the aftermath of floods caused by recent cyclones. Support was provided through RAF0051, 'Supporting Specific Needs in the African Region Due to Emergencies'.

The project RAF5073, 'Strengthening Africa's Regional Capacity for Diagnosis of Emerging or Re-emerging Zoonotic Diseases, including Ebola Virus Disease (EVD), and Establishing Early Warning Systems' continued strengthening regional capacities to identify zoonotic diseases early and in safe and secure conditions. In 2019, focus was placed on strengthening the capacities of national veterinary laboratories to carry out early identification through genetic sequencing. This allowed Morocco, for instance, to adapt its vaccination campaign efficiently to deal with an outbreak of foot-and-mouth disease that started in January 2019. Thanks to the genetic identification of a new strain of the foot-and-mouth disease virus, Morocco could use a matching vaccine and implemented successful vaccination campaigns, rapidly halting the spread of the disease and returning to foot-and-mouth disease-free status.

In Rwanda, the country developed a curriculum under RWA0002, 'Strengthening National Human Capacity and Research in Nuclear Sciences and Technology', that enabled

"In 2019, focus was placed on strengthening the capacities of national veterinary laboratories to carry out early identification through genetic sequencing. This allowed Morocco, for instance, to adapt its vaccination campaign efficiently to deal with an outbreak of foot-and-mouth disease that started in January 2019."

the launch of a human resources development programme in nuclear physics, supporting national efforts to establish a Centre for Nuclear Science and Technology. A business plan was also developed through the project for the establishment of a Nuclear Science Centre at the College of Science and Technology, University of Rwanda.

Regional cooperation

AFRA is the principal framework for promoting technical cooperation among developing countries in Africa, and for enhancing regional cooperation among its States Parties. The revised text of the AFRA Agreement was endorsed at the 30th Meeting of AFRA Representatives, which took place on the margins of the 63rd annual session of the IAEA General Conference. The revised AFRA Agreement will be of indefinite duration and, as a result, there will be no need for States Parties to renew their acceptance of the Agreement every five years, as was the case before. At the same meeting, participants endorsed the 2018 AFRA Annual Report, the AFRA regional project designs formulated for the 2020–2021 TC cycle and the recommendations adopted by the 30th Technical Working Group Meeting.

The AFRA Chairperson, with the support of the Secretariat, held a series of meetings with Permanent Representatives of the Vienna-based African Group and donor countries in Vienna in early 2019, to share information on AFRA project-related achievements and success stories, and to seek further support for the implementation of the unfunded portion of the AFRA programme. The series of meetings led to an increase in extrabudgetary contributions. The AFRA Chairperson also encouraged AFRA States Parties to pay their shares to the AFRA Fund, resulting in an increase in contributions.

The 30th AFRA Technical Working Group Meeting was hosted by the Government of South Africa in Johannesburg in July 2019. At the meeting, the Chairs of AFRA Committees and National Coordinators deliberated on issues related to AFRA policy and the AFRA programme. The meeting adopted concrete recommendations to further enhance regional cooperation in Africa.

AFRA regional designated centres provided useful services in different nuclear-related areas in the region throughout 2019, and hosted fellowship training, meetings and training courses. Expert services were also provided by qualified staff from these centres. AFRA regional designated centres help strengthen relationships and the exchange of information between nuclear institutions in the region.



Participants at the 30th AFRA Technical Working Group Meeting in Johannesburg, South Africa. (Photo: L. Abdul-Malik/IAEA)

Contributions to the AFRA Fund

The total contribution of AFRA States Parties to the AFRA Fund came to over €391 500, demonstrating the Parties' continued commitment to AFRA activities and their willingness to support regional ownership of the programme. The funding will be allotted to AFRA projects in 2020 to support the implementation of unfunded activities.

Table 10: Voluntary contributions to the AFRA Fund for TC activities, 2019 (in euros)

Country	Amount received	Country	Amount received
Algeria	29 308	Namibia	9669
Burkina Faso	2076	South Africa	292 983
Kenya	10 464	Sudan	7039
Madagascar	4462	Uganda	3139
Mauritania	3077	United Republic of Tanzania	13 839
Morocco	13 927	Zambia	1538
		TOTAL	391 521

C.2. ASIA AND THE PACIFIC

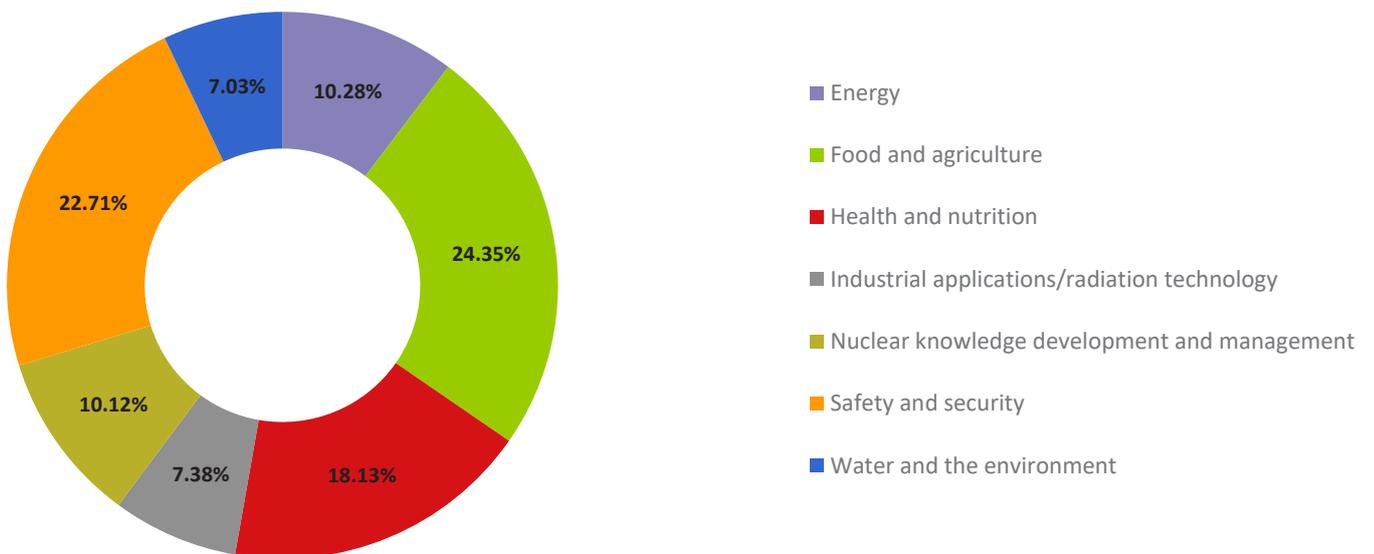


Figure 10: Actuals in the Asia and the Pacific region in 2019 by technical field.

Regional highlights in Asia and the Pacific

In 2019, the TC Programme provided assistance to 38 countries and territories in the Asia and the Pacific region in areas including health and nutrition, food and agriculture, energy, nuclear knowledge development and management, water and the environment, and industrial applications and radiation technology, through 258 national and 65 regional projects. In 2019, the programme achieved an implementation rate of 87.3% in the region.

CPFs signed in Asia and the Pacific in 2019	
Afghanistan	Sri Lanka
Kuwait	Syrian Arab Republic
Pakistan	

Five Member States in the region signed Country Programme Frameworks. There are now 30 valid CPFs in place in the region.

A week-long workshop in Vienna brought together over 60 NLOs and National Liaison Assistants from more than 30 countries and territories in the region to exchange ideas and best practices. Summaries of national journeys that led to concrete achievements in the management of national TC programmes were compiled, and three action plans were agreed to sustain lessons learned and move forward. The first aims to finalize a compendium of examples of ‘journeys to success’ and lessons learned in enhancing the impact of the TC programme. The second establishes actions for the optimum utilization of existing partnerships and new partnerships established in new thematic areas, and the third identifies actions and common references to enhance efficiency and effectiveness of the TC programme in the region.



National Liaison Officers and National Liaison Assistants from over 30 countries exchanged ideas and best practices at a workshop in Vienna. (Photo: O. Yusuf/IAEA)

Project highlights

The journey to reach 1 million students by 2021 continued in 2019 under the regional project RAS0079, ‘Educating Secondary Students and Science Teachers on Nuclear Science and Technology’. The project is working to develop tools and resources for nuclear education in secondary schools in the Asia and the Pacific region. Four train-the-trainers workshops hosted in Australia, Malaysia, the Philippines and the United States of America reached teachers from 17 countries across Asia and the Pacific in 2019. Teaching tools were also provided to facilitate student understanding of the concepts related to nuclear science and technology. The pilot countries Indonesia, Malaysia and the Philippines have successfully demonstrated the importance of nuclear science and technology to secondary

schools and in 2019 they introduced nuclear science and technology into their national secondary school curricula. Other countries participating in the project, including Oman, Sri Lanka and Thailand, have conducted outreach, extracurricular activities or teacher training related to nuclear science and technology in secondary education.

The Agency continued to support the efforts of Member States in the region to enhance the protection of workers, the public and the environment, working to strengthen radiation safety infrastructure under the regional projects RAS9080, 'Enhancing National Capabilities on Occupational Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards', and RAS9089, 'Strengthening Radiation Safety Infrastructure'. In 2019, this support contributed to the revision and updating of national regulations in line with General Safety Requirement Part 3 in Iraq, Islamic Republic of Iran, Kuwait, Lebanon, Malaysia, the Philippines and Thailand, the improvement of quality management systems in individual monitoring service laboratories in Bangladesh, Islamic Republic of Iran and Nepal, and operationalization of national dose registries in China, Iraq and Nepal.

The first interactive e-learning course on therapeutic applications of radioisotopes and radiopharmaceuticals was offered in 2019, supported by RAS0075, 'Networking for Nuclear Education, Training, and Outreach Programmes in Nuclear Science and Technology in the Framework of ANENT (Asian Network for Education in Nuclear Technology)'. Fifty-one participants from 16 countries in the region were trained online across three overarching modules addressing radiochemistry, radioisotopes and radiopharmaceuticals.

Nuclear medicine and cancer treatment services in Bangladesh are expanding with Agency support. A new nuclear imaging machine – an essential tool for advanced nuclear medicine diagnosis of health conditions such as cardiovascular diseases and cancer – is now up and running, enabling more than 500 patients a year to receive vital medical examinations. Bangladesh is also carrying out a major upgrade to its radiation oncology services, supported by a corps of staff who have been trained abroad in advanced medical institutions through over twenty national training programmes supported by the IAEA technical cooperation project BGD6026, 'Building Capacity for Improved Cancer Management through Strengthening Human Resources in the Field of Radiation Oncology'. Several fellowships and scientific visits on the operation and clinical applications of PET-CT and SPECT – CT, were conducted throughout 2019, and participation in international meetings on radiation oncology was also supported.

In 2019, Myanmar significantly strengthened its capacities to deliver 3D conformal radiotherapy, IMRT and 3D image guided brachytherapy, and to perform routine QA/QC brachytherapy checks and conduct cervical cancer brachytherapy treatment planning. A total of four radiation oncologists and four medical physicists were trained, and dosimetry and immobilization devices were procured. Myanmar also successfully strengthened the conservation of Inle Lake through improved monitoring and verification of water quality, leading to the implementation of a sustainable watershed management approach. IAEA assistance in the form of staff training and the provision of equipment and analysis facilitated the application of water quality monitoring and analysis techniques, resulting in the development of a comprehensive plan to manage the water resources of Inle Lake. Activities in 2019 were supported under TC project MYA5027, 'Monitoring and Assessing Watershed Management Practices on Water Quality and Sedimentation Rates of the Inle Lake - Phase II'.

The Agency continued to provide support to Yemen in 2019 in breeding small ruminants in the highlands under a national project aiming to help farmers improve how they run and manage small ruminant farms, TC project YEM5014, 'Improving Management of Small Ruminants'. Nine specialists from the Ministry of Agriculture and Irrigation were trained in Jordan to improve their skills in artificial insemination, including diagnosis and evaluation of fertility in small ruminants. The project contributes to Yemen's national food security by increasing livestock productivity and farmer income – livestock production, and raising small ruminants in particular, is a key source of income for the rural community.

“Nuclear medicine and cancer treatment services in Bangladesh are expanding with Agency support. A new nuclear imaging machine – an essential tool for advanced nuclear medicine diagnosis of health conditions such as cardiovascular diseases and cancer – is now up and running, enabling more than 500 patients a year to receive vital medical examinations.”

Regional cooperation

In 2019, significant accomplishments were made under the Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA), at both the policy and the programmatic level. Substantial progress was made in updating the working mechanisms of the ARASIA Agreement. Since its adoption in 2018, three States submitted their instrument of acceptance of the revised ARASIA Agreement, which will enter into force on 28 July 2020 and will remain in force indefinitely.³¹ In addition, the ARASIA Board of Representatives established the ARASIA Programme Committee to enhance the efficiency and effectiveness of the ARASIA TC programme from planning through implementation and monitoring. An action plan was developed for resource mobilization during a meeting in July 2019 in Vienna.

ARASIA designated resource centres in human health were expanded to include secondary standards dosimetry laboratories in 2019, which will increase the visibility and sustainability of the multiple high-level facilities in ARASIA States Parties and facilitate access to science and technology for national and regional development across the region. The TC programme for 2019 addressed new thematic areas of interest to ARASIA States Parties, such as enhancing capacity in internal dosimetry for occupational exposure. The programme continued to study air pollution with the aim of developing a quality database for the region. In addition, the programme continued to strengthen and harmonize nuclear and radiological emergency preparedness and response. Considerable attention was given to identifying best agricultural practices to combat land degradation in the region. This focus on harmonization and on leveraging best practices will lead to a more efficient programme, one that shows sustainable results and has a positive impact on society and on human wellbeing across the region.

RCA continued its successful progress in contributing to socioeconomic development in the region. Two representatives' meetings (one in Sri Lanka and the other in Vienna) were convened under the Chairmanship of Sri Lanka. Fourteen regional training courses, two regional workshops and seventeen expert missions were carried out under the RCA, and an implementation rate of 94% was achieved. In addition, the RCA Regional Office organized an expert meeting in April to develop e-learning modules on nuclear medicine for RCA States Parties in Busan, Republic of Korea, inviting 14 experts including nuclear medicine experts from the region. The experts agreed on a total of 30 modules in five different areas, comprising five in neurology, eight in oncology, eight in endocrinology,



Describing sampling techniques to trainees, Nanning, China. (Photo: Z. Huang, Guangxi University, China)

³¹ The text of the revised ARASIA Agreement was published in 2019 as INFCIRC/929.

six in cardiopulmonary and three in physics. All modules were subsequently developed during the course of the year.

Within the framework of the RCA, work continued on a project aimed at enhancing the capacities of countries in the Asia and the Pacific region to use nuclear techniques to assess and improve soil and water quality, and to implement best agricultural practices to minimize land degradation and enhance crop productivity. Through the project, RAS5084, 'Assessing and Improving Soil and Water Quality to Minimize Land Degradation and Enhance Crop Productivity Using Nuclear Techniques (RCA)', the Agency organized a regional training course to provide basic practical training to 20 participants from 13 RCA States Parties on the use of multiple stable isotopes techniques to monitor the source and transport of agricultural non-point source pollutants (fertilizers and pesticides) in agro-ecosystems, at Guangxi University in Nanning, China. The course, which included conceptual experimental design and two days of field demonstrations, will help improve the use of nuclear and isotopic techniques for soil, water and environmental investigations in participating countries.

RAS5081, 'Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques (RCA)', a project with the objective of improving food safety, enhancing consumer confidence and increasing trade by establishing a robust and independent means of verification of origin of foodstuffs, also continued in 2019. Under the project, a regional training course was organized in Beijing, China, to train participants on the use of isotope ratio mass spectrometry, molecular spectroscopy, and inductively coupled plasma mass spectrometry for verifying food authenticity. The course, attended by 23 participants from 14 different RCA States Parties, was an important step in ensuring food safety in the region.

South-South and triangular cooperation continued to grow in 2019 through the framework of Practical Arrangements with the Association of Southeast Asian Nations in nuclear applications, safety, security and safeguards. Practical Arrangements with Cambodia, Lao People's Democratic Republic and Viet Nam were signed on 17 September 2019. The Arrangements provide a framework for collaboration in a broad range of priority areas, from non-destructive testing and other industrial applications to nuclear medicine and mutation breeding. In this new framework, Viet Nam is expected to support both short- and long-term education and training programmes in Cambodia and Lao People's Democratic Republic.



Practical Arrangements for Triangular Cooperation with Cambodia, Lao People's Democratic Republic and Viet Nam were signed in September 2019. (Photo: O. Yusuf/IAEA)

C.3. EUROPE

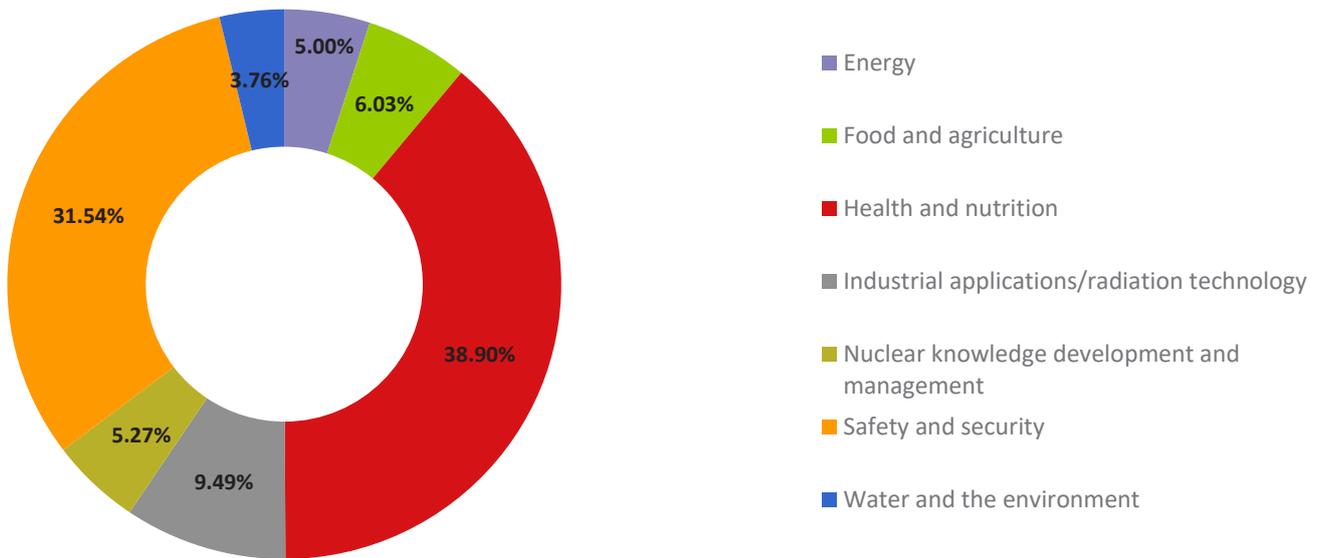


Figure 11: Actuals in the Europe region in 2019 by technical field.

Regional highlights in Europe

In 2019, 33 Member States in Europe and Central Asia participated in the TC programme through 126 national and 37 regional projects. The year-end implementation rate for the region was 87.9%. The programme focused mainly on the thematic areas of safety and security and health and nutrition, with more than 70% of the disbursements (actuals) dedicated to projects in these areas.

CPFs signed in Europe in 2019

Latvia	North Macedonia
Lithuania	Romania

Four Country Programme Frameworks were signed in 2019. One regional workshop was conducted for seven Member States to facilitate the development of their individual CPFs.

The IAEA participated in the Evaluation of the United Nations Partnership for Sustainable Development Framework for Georgia. Twelve UNDAFs in total have been co-signed in Member States participating in the TC Europe programme to date.

To guarantee high quality, results based projects with clear objectives and outcomes, NLO review meetings were organized in April and November, on the application of results based management and the logical framework approach for project design, to finalize the regional programme.

Project highlights

Over the past decade, through several technical cooperation projects, the Agency has helped the Government of Uzbekistan to improve radiotherapy infrastructure in four oncology centres throughout the country. IAEA support included the training of clinical staff and the provision of new treatment equipment, which has helped these centres to provide sustainable, quality radiotherapy treatment that is improving the quality of life and overall survival rates for cancer patients in Uzbekistan. Uzbekistan's hospital records confirm that access to radiotherapy services has increased and that more cancer patients are receiving treatment. For example, by the end of 2019, over 10 000 patients had been treated in Tashkent City Oncology Centre by a new radiotherapy teletherapy cobalt-60 machine that was provided in 2012. In 2019, Agency support was provided through a scientific visit and two fellowships to build the capacities of Namangan Regional Oncology Centre. In addition, expert missions were dispatched to review the commissioning of two new linear accelerators (linacs) in Tashkent City Republican Oncology Centre, received through Islamic Development Bank financing, and to conduct training for clinical staff to deliver advanced treatment methods with the new machines.

Through the four-year regional TC project RER9144, 'Building Capacity for Infrastructure Development and Safety Assessment of Water-Cooled Water Moderated Power Reactor Technology with Advanced Safety Features: The Case of WWER/PWR', the knowledge of 226 nuclear power plant regulators, operators and technical support organization staff from 16 countries was enhanced. The project focused on nuclear power infrastructure and on safety assessment of pressurized water reactors. By developing skills that strengthen safety and by encouraging the exchange of information and knowledge among Member States, the project has helped to ensure the safe and sustainable use of nuclear power.

Capacities to monitor environmental pollution, as well as the ability to assess the effects of climate change, were greatly enhanced in the region by the implementation of regional project RER7009, 'Enhancing Coastal Management in the Adriatic and the Black Sea by Using Nuclear Analytical Techniques'. Hands-on training was provided through the project to improve and harmonize sampling methodologies, and new data was obtained using nuclear and isotopic techniques. IAEA Member States bordering on these two water bodies are now able to produce reliable data, based on which, recommendations to tackle pollution and effects of climate change can be formulated.

The Europe region has the highest number of Member States working on the decommissioning of nuclear facilities. A workshop with associated site visits, held in October at the Cadarache Nuclear Centre, French Alternative Energies and Atomic

“Capacities to monitor environmental pollution, as well as the ability to assess the effects of climate change, were greatly enhanced in the region by the implementation of regional project RER7009.”

Energy Commission, France, addressed the planning and costing of research reactor decommissioning. The event supported the sharing of national experiences on decommissioning costing for research reactors, including the development of physical and radiological inventories – these being key inputs to the cost calculation. It also addressed methodologies for development of the necessary inventory information. Much of the workshop was devoted to ‘hands on’ group exercises, during which time participants developed waste inventories based on radiological data provided by the experts for major reactor components. The groups also developed basic cost estimates for a research reactor decommissioning projects, again using source information provided by the experts.

Turkey received Agency support for its nuclear power programme in 2019 in the form of two expert missions. The results of the review of draft radioactive waste management regulations were discussed, focusing on radioactive waste and spent fuel management, authorization of radioactive waste management facilities, and the siting of near surface disposal facilities.

An expert mission to Poland in October, supported through national project POL2019, ‘Supporting the Development of Nuclear Power Infrastructure’, provided assistance on the seismic hazard assessment of low seismicity nuclear power plant (NPP) sites, and participated in site visits to two potential locations.

Regional cooperation

In April, NLOs adopted a Strategic Framework for Technical Cooperation in the Europe region for 2019–2025. This framework, together with Country Programme Frameworks, provided high-level strategic guidance for the planning and design of the 2020–2021 TC programme in Europe and Central Asia.

C.4. LATIN AMERICA AND THE CARIBBEAN

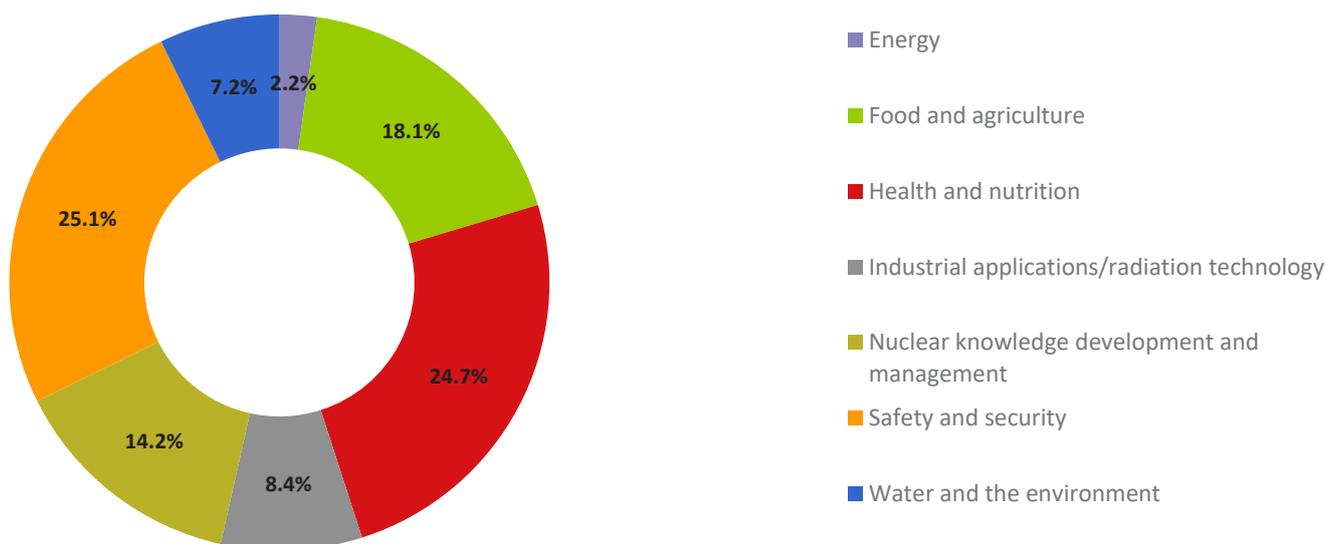


Figure 12: Actuals in the Latin America and the Caribbean region in 2019 by technical field.

Regional highlights in Latin America and the Caribbean

In 2019, 31 Member States, including one least developed country (Haiti), were supported through 144 active national projects and 42 active regional projects. The programme achieved an implementation rate of 93.4% in the region.

Five Member States successfully developed and signed their Country Programme Frameworks.

In 2019, the Agency and the Pan American Health Organization worked closely to support Caribbean Member States in their efforts to achieve better adherence to International Health Regulations and improved preparedness and response to radiological emergencies, based on IAEA safety standards and technical guidance. In April, at the Technical Advisory Committee meeting of the Caribbean Disaster Emergency Management Agency (CDEMA), the Agency proposed broadening the scope of coordination between the IAEA and CDEMA to improve national emergency preparedness and response to nuclear or radiological emergencies in the Caribbean Region.

CPFs signed in Latin America and the Caribbean in 2019

Belize El Salvador

Brazil Guyana

Dominica



Wilfred Peter Elrington, Minister of Foreign Affairs of Belize, signed Belize's Country Programme Framework for the period of 2019–2023. (Photo: M. Zapata Cazier/IAEA)

In addition, the Agency presented its overall programme of work in the Caribbean region related to radiation medicine at the Pan American Health Organization/World Health Organization Regional Meeting on Improving Quality Assurance of Radiology Services in the Caribbean. The purpose of the meeting was to provide the countries with tools to develop and subsequently implement quality assurance programmes.

In July, the Agency funded the participation of a regional expert at the 12th Meeting of The Caribbean Plant Health Directors Forum. The Forum was hosted by the United States Department of Agriculture, Animal and Plant Health Inspection Service, together with the Greater Caribbean Safeguarding Initiative, the Caribbean Agricultural Health and Food Safety Agency, the Caribbean Community Secretariat, the FAO and the Inter-American Institute for Cooperation on Agriculture. IAEA cooperation in agriculture with the Caribbean, including in the area of pest control, was presented at the meeting, which also provided a forum for the discussion of matters related to protecting the region's agriculture

and environment from harmful pests and diseases, and minimizing their impact. The harmonization of regional policies regarding phytosanitary measures to facilitate trade in plant and plant products was also discussed.

In February, the Agency hosted a regional five-day workshop for representatives from Latin America and the Caribbean, pioneering a novel approach which enabled the simultaneous design of 22 national projects, primarily in the area of enhancing radiation protection and nuclear safety. At the workshop, 33 participants from 19 countries applied the IAEA's new strategic planning tool for the first time to design technical cooperation projects that will deliver made-to-measure solutions. The new strategic planning tool facilitates the design of effective technical cooperation projects by enabling the identification of persisting gaps in radiation protection and by supporting the involvement of relevant national stakeholders. It guides country teams through a step-by-step process to prioritize and address their technical and safety-related gaps. Alongside the logical framework approach, the Strategic Planning Tool will become a standard element in the development of safety-related projects in the region.

In March, 33 NLOs and Assistants from Latin America and the Caribbean region attended a training course that provided a comprehensive overview of the work carried out by the Agency through the technical cooperation programme, and clarified the obligations, expectations and responsibilities associated with their roles.

Project highlights

Marine-Coastal Research Network (REMARCO), a network for cooperation in marine science and communication that connects 14 countries in Latin America and the Caribbean was established in 2019 to facilitate decision-making in the context of the common challenges and vulnerabilities present in the marine environment. With the support of the Agency, REMARCO's goal is to raise awareness of threats to the ocean and to help decision makers in the region take evidence-based policy action. The participating countries shared challenges in their marine and coastal environments: marine pollution, ocean acidification, harmful algal blooms and microplastics. With the support of the IAEA's technical

“Marine-Coastal Research Network (REMARCO), a network for cooperation in marine science and communication that connects 14 countries in Latin America and the Caribbean was established in 2019 to facilitate decision-making in the context of the common challenges and vulnerabilities present in the marine environment.”



Marine sample preparation. (Photo: CICA/Costa Rica)

cooperation programme, scientists from the network use nuclear-derived techniques to monitor these phenomena and come up with appropriate remediation or mitigation proposals. The technicians and scientists who now form the membership of REMARCO have collected almost 30 000 samples of water and marine organisms and have published numerous scientific papers on various threats to the ocean, supported by the IAEA with the provision of equipment and training.

Regional cooperation

ARCAL celebrated its 35th anniversary in 2019 with the release of a video highlighting its achievements. Over the past 35 years, more than 160 IAEA regional technical cooperation projects have been implemented under the framework of ARCAL. Some key examples include the curbing of fruit fly infestations using the SIT in countries including the Dominican Republic, Guatemala and Mexico. Radiation-induced mutation techniques have led to the development of new varieties of rice, tomato and quinoa, resulting in stronger crops with higher yields, greater resistance to disease and pests, and higher tolerance of drought. ARCAL projects have also helped countries to improve the management of precious water resources and to monitor marine pollution.

Considerable progress has been made in the region in the use of nuclear medicine and radiotherapy for better diagnosis and treatment of diseases. ARCAL has contributed to the organization of key regional training programmes for oncologists, specialists in nuclear medicine, radiotherapy technicians and medical physicists. More recently, ARCAL has taken important steps in strengthening the sustainability of national nuclear institutions and in attracting more young professionals and young women to its activities.

ARCAL's anniversary was also marked at the XX Meeting of the ARCAL Technical Coordination Board in May in Cuba. The presidency of ARCAL was transferred from Mexico to Cuba during the event, and participants approved new communication and partnership plans and the regional designs for the 2020–2021 TC cycle.

The XX Meeting of the Board of ARCAL Representatives was held in September on the margins of the 63rd IAEA General Conference. Representatives reviewed the achievements of the agreement in the last 35 years, including communication and partnership activities. The Agreement was extended for a further five years, and agreement was reached on the plan of action for drafting the new Regional Strategic Profile, 'Agenda ARCAL 2030', to succeed the current Regional Strategic Profile for 2016–2021.



ARCAL Representatives celebrate ARCAL's 35th anniversary at the XX Meeting of the Board of Representatives. (Photo: J. Howlett/IAEA)



Achievements under the current ARCAL Regional Strategic Profile were evaluated in 2019 before National ARCAL Coordinators and Regional Experts began work on the formulation of Agenda ARCAL 2030. (Photo: O. Yusuf/IAEA)

ARCAL emphasized the implementation and enhancement of its communication plan in 2019. ‘Nuclear communicators’ have been assigned in each States Parties to support project counterparts, establish procedures for the systematic production of communication material for all ARCAL projects, and to update the ARCAL website and social media. The communication strategy goes hand-in-hand with ARCAL’s partnership working group, which also developed a new strategy in 2019 in order to enter into a greater number of strategic alliances with internal and external partners.

In 2019, the Agency, working with Member States and CARICOM institutions, facilitated the completion and endorsement of the Regional Strategic Framework for Technical Cooperation with IAEA-CARICOM Member States: 2020–2026. This strategic document outlines common challenges facing all Member States in the region, and presents a method and timeline for addressing them through the safe and secure use of nuclear science and technology.



The Regional Strategic Framework will be used to identify and develop needs- and evidence-based regional projects during the 2022–2023 technical cooperation cycle. (Photo: C. Karle/IAEA)

C.5. INTERREGIONAL PROJECTS

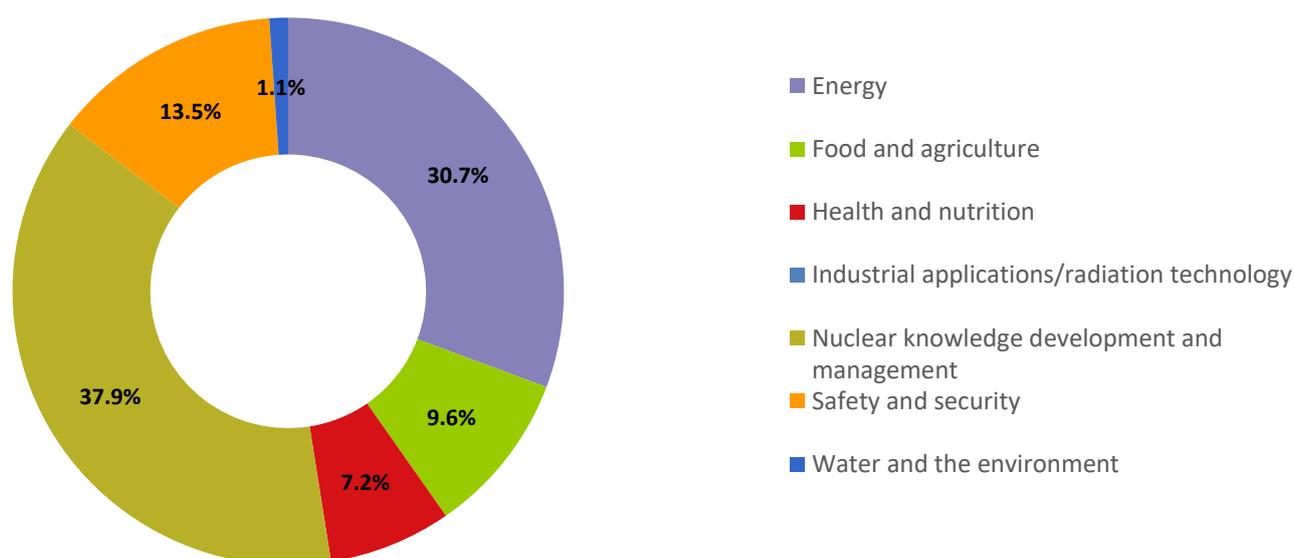


Figure 13: Interregional actuals in 2019 by technical field.

Interregional projects deliver technical cooperation support across national and regional boundaries and address the common needs of several Member States in different regions. In 2019, actuals under interregional projects totaled €7.7 million. Two interregional projects were in closure status at the end of the year.

Interregional projects delivered important support to Least Developed Countries and Small Island States in 2019. In 2019, TC project INT0097, 'Contributing to the Development of Least Developed Countries by Building Human and Institutional Capacities in Nuclear Sciences and Technology', strengthened Member State capacities to communicate the benefits of nuclear science and technology to their populations, while project INT0093, 'Applying Nuclear Science and Technology in Small Island Developing States (SIDS) in Support of the Sustainable Development Goals and the SAMOA Pathway', is helping IAEA SIDS Member States to achieve the SDGs and the Small Island Developing States Accelerated Modalities of Action Pathway (SAMOA) in areas including marine environment, cancer, nutrition and food security.

In 2019, interregional projects also helped Member States to exchange experiences on feasibility studies and project management for the development of uranium mines and mills, and conventional uranium production. In addition, they delivered support to Member States considering nuclear power or preparing for its introduction.

Finally, INT9182, 'Sustaining Cradle-to-Grave Control of Radioactive Sources', has played an important role in improving safety in Member States. At the Final Coordination Meeting in November 2019, participants noted that approximately two-thirds of the 32 participating countries have significantly strengthened their capacity in safety, security and technological solutions. After four years of implementation, the project produced measurable improvements in the number of countries who have developed policies and strategies, enhanced their regulatory infrastructure, developed safety cases, as well as established and maintained registries and inventories of sealed radioactive sources – including disused sealed radioactive sources (DSRSs). Several countries are already using or contemplating the use of appropriate technologies for waste management including disposal options. The Disused Sources Integrated Decision Evaluation Support Tool was tested in Indonesia and Jordan, and rolled out to participating countries. The objective

of the decision-aiding tool is to provide Member States with guidance and a proposed methodology to support informed decision-making about end-of-life management options, focusing on disposal options, based on existing and projected DSRS inventories, source activity and waste classes.



Interregional training course on search and recovery of DSRSs. (Photo: C. Benitez-Navarro/IAEA).

C.6. PROGRAMME OF ACTION FOR CANCER THERAPY (PACT)³²

PACT highlights in 2019

In 2019, the Agency, through PACT, continued to support the efforts of low and middle income countries to integrate radiation medicine into national comprehensive cancer control programmes. Activities focused on reviewing and strengthening national capacities, addressing funding gaps in IAEA cancer-related projects and mobilizing additional resources for sustainable cancer services.

imPACT Reviews

In 2019, five Member States received imPACT Reviews. Conducted upon the request of a country's Ministry of Health and financed by extrabudgetary contributions, imPACT Reviews draw on the experience and knowledge of international experts nominated by the IAEA, WHO and the International Agency for Research on Cancer (IARC), covering all areas of cancer control. Over the last 15 years, the IAEA has conducted 101 imPACT Reviews in 92 Member States.

imPACT review missions in 2019

Armenia	Seychelles
Burkina Faso	Sri Lanka
Ecuador	

Armenia, April 2019

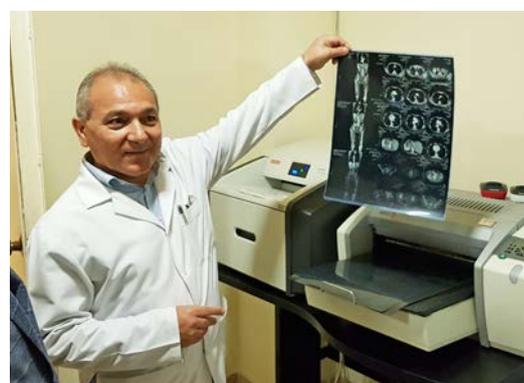
Cancer is estimated to account for 28% of all deaths in Armenia, well above the global average of 16%. Recommendations from the imPACT Review aimed to enhance the cancer registration and surveillance system, facilitate national cancer control planning and coordination, expand technical cooperation with relevant international partners and provide opportunities for cancer-related education and research activities.

Burkina Faso, July 2019

Cancer has become a public health priority in Burkina Faso, in particular women's cancers. Patients face stigma, are diagnosed late, and have only limited access to medicines, especially in rural areas. The Ministry of Health plans to use the imPACT Review to strengthen coordination and capacity of national and regional stakeholders involved in cancer control planning, develop a strategy to establish and expand radiotherapy services with adequate workforce, and develop national training programmes for key cancer health professionals.

Ecuador, April 2019

Cancer is on the rise in Ecuador, with more than 28 000 new cases and over 14 500 cancer related deaths in 2018. The imPACT Review Report helped Ecuador to identify its cancer control needs, and to strengthen national coordination capacity and monitor the implementation of the current national cancer control plan. In addition, based on the imPACT Review, the country plans to design radiotherapy services, with associated radiation safety measures and legislation.



Discussing the quality and use of radiology services at Yerevan's National Centre of Oncology. (Photo: A. Juric /IAEA)



Discussions with medical staff at Lorentia Clinic's Biochemistry Laboratory in Bobo Dioulasso. (Photo: A. Benedicto /IAEA)

³² Section C.6 responds to section B of resolution GC(63)/RES/9 on the Programme of Action for Cancer Therapy.



John Lara, chief of diagnostic anatomic pathology at the Ecuadorian Social Security Institute Teodoro Maldonado Carbo Hospital in Guayaquil, explains to mission experts how cancer patient records are stored. (Photo: A. Benedicto/IAEA)



imPACT expert Yavuz Anacak reviews cancer treatment planning with medical staff at the Karapitiya Teaching Hospital. (Photo: G. Arias de Goebel/IAEA)

Sri Lanka, October 2019

Cancer is a leading cause of mortality in Sri Lanka. The Government has accelerated efforts to alleviate the burden of disease. Continuing its collaboration with the IAEA it requested an imPACT Review to inform and update the national cancer control plan. The Review recommendations provided guidance for the scale up of cancer diagnosis and treatment services, as the country aims to decentralize radiotherapy facilities with advanced equipment and address geographical disparities in access to cancer care. Follow-up activities began almost immediately following the Review.

Seychelles, July 2019

Cancer is a growing public health challenge in Seychelles, with 1048 new cancer cases registered from 2012 to 2016. The imPACT Review helped address the need for planning and training of human resources, focusing on the education of nurses and allied health workers, and on increasing access to radiotherapy services. In addition, recommendations from the Review also addressed the data collection process and the strengthening of the national cancer registry to provide evidence-based planning for Seychelles' response to cancer.



imPACT Review experts Sergei Nazarenko, Rajiv Prasad and Emmanuel Luyirika observe and discuss patient management at the Oncology Ward of the Seychelles Hospital. (Photo: A Juric /IAEA)

Development of strategic documents

In close cooperation with the WHO and its respective regional offices, expert advisory assistance was provided to Panama to support the development of a national cancer control plan. Panama's national cancer control plan 2019-2029 was officially launched by the Ministry of Health in June 2019. Planning and coordination with WHO was undertaken for a similar technical support to be provided to Viet Nam and Islamic Republic of Iran in 2020.

The Agency supported Chad, Eswatini, Kenya, Liberia and Sierra Leone in developing bankable documents for establishing nuclear medicine and radiotherapy services.

Advocacy, partnership building and resource mobilization

Partnership building and outreach

Within the Agency, the collaboration among internal divisions was further strengthened, through streamlining PACT activities into TC programme designs and implementation; improving the impACT Review processes and procedures; expanding the pool of cancer control experts; and, ensuring that impACT Review findings and recommendations are relevant in follow up support on radiation safety infrastructure by the Division of Radiation and Waste Safety and in the development of Integrated Nuclear Security Support Plans by the Division of Nuclear Security.

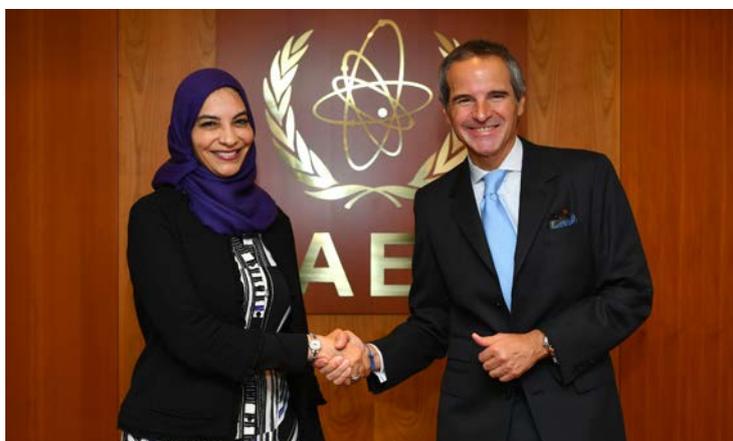
Practical Arrangements were signed with the St. Jude Children's Research Hospital for joint collaboration to combat childhood cancers in developing countries, including through raising awareness of childhood cancers, mobilizing resources to support Member States in the establishment of nuclear and radiation medicine services, increasing training for professionals in the field of radiotherapy, and supporting research in paediatric radiation oncology and related areas.

Current partners were increasingly engaged throughout the year, including private sector and international financing institutions, to seek training opportunities for health professionals and raise funds to boost cancer control activities. The partnership with the Islamic Development Bank was further strengthened through the joint launch of the Women's Cancers Partnership Initiative at the Scientific Forum held at the 63rd IAEA General Conference to increase cancer services for women in common Member States. The Bank announced a plan to mobilize an initial US \$10 million in grant funding, which will help unlock further Islamic Development Bank resources for the initiative in support of unfunded women's cancer related TC activities. A dedicated Memorandum of Understanding was signed to provide the framework for the implementation of this partnership.

Plans in support of activities to address women's cancer were also announced by various partners, including France, Monaco, Russian Federation, Sweden and the United States of America, as well as from the private sector (Varian, Elekta), with the aim of contributing to improving cancer treatment accuracy and the upgrading of skills of medical professionals treating cervical and breast cancer patients.

The IAEA convened a meeting of key partners in cancer control attended by representatives from the WHO, the International Agency for Research on Cancer, the United Nations Office on

“Practical Arrangements were signed with the St. Jude Children's Research Hospital for joint collaboration to combat childhood cancers in developing countries.”



Dr Hayat Sindi, Chief Advisor to the Islamic Development Bank President, with DG Rafael Mariano Grossi. (Photo: D. Calma/IAEA)

Drugs and Crime (UNODC) and the Union for International Cancer Control (UICC), to finalize revisions of the current imPACT Review methodology (a follow up to a meeting held in October 2018) and to identify opportunities to strengthen collaboration in the next biennium, including for planning of joint imPACT Reviews. The meeting brought concrete and visible improvements to the methodology of imPACT Reviews that will enable more effective engagement with Ministries of Health and greater partner collaboration on the Reviews and follow-up activities. The methodology was improved in terms of scope, ownership and relevance to the national cancer planning processes, the quality and efficiency in data collection and data analysis and systematic follow up with Member States to measure effectiveness of imPACT Reviews. It will be applied as of 2020.

In addition to finalizing the methodology, the IAEA and its partners also agreed on

ways to strengthen the planning and delivery of joint activities, to improve coordination of partners at country level, to complement the work of other UN and development partners and to streamline support through the UN country team, WHO Regional and Country Offices and IAEA National Liaison Office, to ensure ownership and sustainability. Partners also agreed to improve exchanges of information to existing and new cancer control activities, to enhance public communication and to achieve greater synergy and impact of interventions.



Prebo Barango, Medical Officer for the Inter-Country Support Team for Eastern and Southern Africa at the World Health Organization, speaks about the heavy burden of cancer in Africa at the joint coordination meeting on cancer control between IAEA, WHO, IARC, UICC and UNODC. (Photo: J. Howlett/IAEA)

Resource mobilization

Member States, intergovernmental and non-governmental organizations, as well as the private sector continued to show support for the Agency's cancer control activities. A total of €920 788 was received by PACT in 2019 in extrabudgetary contributions from Monaco, Korea Nuclear International Cooperation Foundation, Russian Federation and the United States of America.

PACT also undertook resource mobilization efforts which benefited technical cooperation activities, with funds mobilized from the United States of America, as well as from Niger through a partnership arrangement between the country and the Islamic Development Bank.

List of frequently used abbreviations

AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
Agency	International Atomic Energy Agency
APCs	assessed programme costs
ARASIA	Co-operative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology
ARCAL	Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean
CPF	Country Programme Framework
FAO	Food and Agriculture Organization of the United Nations
IAEA	International Atomic Energy Agency
LDC	least developed country
NPCs	National Participation Costs
NPP	nuclear power plant
PACT	Programme of Action for Cancer Therapy
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
SIDS	small island developing States
SDG	Sustainable Development Goal
TC	technical cooperation
TCF	Technical Cooperation Fund
UNDAF	United Nations Development Assistance Framework
WHO	World Health Organization



Annex 1. Achievements in 2019:
Project Examples by Thematic Sector

Annex 1. Achievements in 2019: Project Examples by Thematic Sector

Health and Nutrition

REGIONAL HIGHLIGHTS

The TC programme in Africa contributes to support Member States' efforts to fight against cancer, cardiovascular diseases and malnutrition using nuclear and nuclear-related techniques. In 2019, this was accomplished through assistance for cancer radiotherapy treatment and diagnostic imaging projects, as well as support for nutrition centres and human resource development.

In the Asia and the Pacific region, the TC programme supported Member States and territories in addressing challenges related to human health and nutrition through 30 national and 10 regional projects and programmes in 2019. The programme supported the fight against cancer by assisting national efforts to devise comprehensive cancer control programmes and by training health professionals in advanced nuclear medicine, radiation oncology and radiology techniques and procedures.

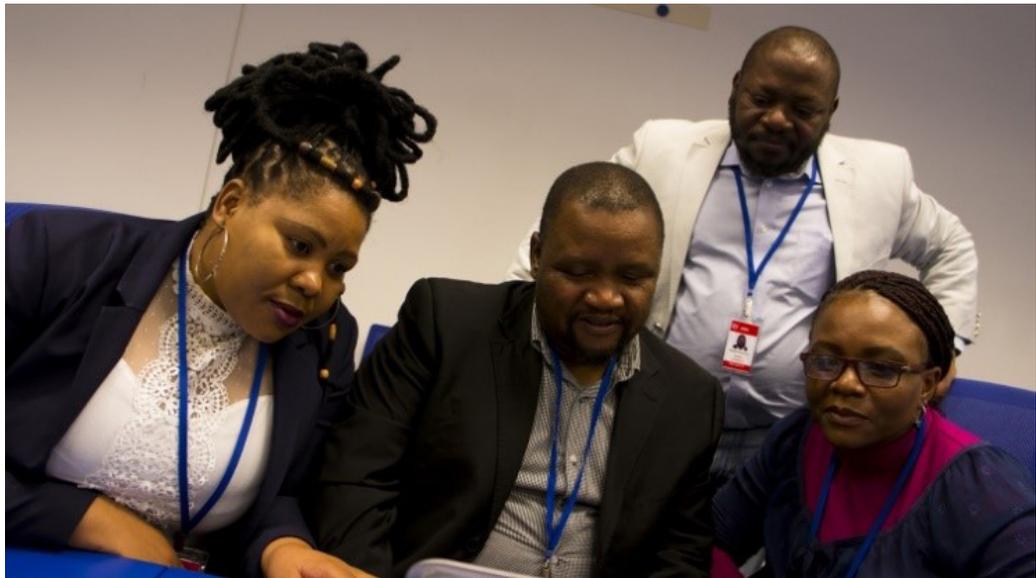
Continued efforts are being made in Europe and Central Asia to provide training opportunities for medical practitioners with the aim of strengthening the application of nuclear technologies and their safe use in human health. Support in 2019 was provided in various areas, such as nuclear medicine, radiation therapy medical imaging and quality assurance/quality control. Both basic capacity building and specialized support to introduce advanced technology was provided. In parallel to the efforts to improve capacity in the use of modern technologies as part of continual professional development, increased attention was also placed on raising radiation safety awareness, and is supporting effective practices in the provision of medical services in the region.

Human health and nutrition remain the main priority in the Latin America and the Caribbean region, where many countries suffer both communicable and non-communicable diseases. In 2019, Member States received substantial support in the establishment of safe and qualitative diagnostic and treatment services for non-communicable diseases. The technical cooperation programme provided assistance through several regional and national projects, supporting human resource development and the procurement of equipment for radiotherapy, nuclear medicine and diagnostic imaging, while ensuring the protection of workers and patients. Furthermore, countries in the region obtained assistance in the development of technical capabilities to study and understand the causes of different types of malnutrition as a basis for the development and adaptation of adequate national public policies.

The extension of the agreement between PACT and the Russian Federation on human resource capacity-building and training for cancer specialists builds on the success of the extensive training programmes funded by the country over the past seven years, which enabled almost 500 Russian-speaking medical practitioners to strengthen capacities for cancer treatment in Europe and Central Asia. The use of nuclear techniques in human health is a priority area for many IAEA Member States in that region, as is addressing the existing gap in qualified and trained medical personnel in the safe and effective use of relevant nuclear technologies. Russia's State Atomic Energy Cooperation "Rosatom" and Russia's Federal Medical and Biological Agency, together with the IAEA, have outlined a long term collaboration plan. The financial and technical support from Rosatom will bridge the gap for regional training courses delivered in Russian and support the continued professional development of medical professionals through additional and targeted courses to address the growing need for high quality, practically-oriented training and skills-building in the region.



"In the Asia and the Pacific region, the TC programme supported Member States and territories in addressing challenges related to human health and nutrition through 30 national and 10 regional projects and programmes in 2019."



Delegates from Eswatini's Ministries of Health and Finance add detail to their draft bankable document for the country's first radiotherapy centre. (Photo: J. Howlett/IAEA)

RADIATION ONCOLOGY IN CANCER MANAGEMENT

Under project RAF0049, 'Supporting Programme Review, Pre-Project Assistance and Capacity Building in Project Design, Monitoring and Evaluation', senior representatives from four African IAEA Member States, Chad, Eswatini, Liberia and Sierra Leone, were helped to develop bankable documents to serve as planning and funding proposals for the establishment of the first radiotherapy facilities in their countries. The meeting was hosted by the IAEA as part of a phased approach to increase cancer services in low- and middle-income countries. Agency staff from across the house worked with the national teams to develop the documents which will be used to inform Governments of the scope of the projects and for resource mobilization.

Immediately after becoming a member of the IAEA in 2012, Rwanda identified initiating radiotherapy services as a key strategic intervention. The IAEA supported Rwanda with the development of a costed plan for the establishment of such services, and with capacity building. Supported by TC project RWA6002, 'Establishing the First Radiotherapy and Nuclear Medicine Centre', Rwanda's first radiotherapy centre, located at the Rwanda Military Hospital, became operational in 2019, and began to provide services with a provisional license from the Rwanda Utilities Regulatory Authority. The new radiotherapy centre serves 40 cancer patients every week on average, and is expected not only to provide more people with access to cancer treatment but also to reduce expensive referrals abroad.

The IAEA has supported Afghanistan's efforts to re-establish its nation cancer treatment capacities through several projects, strengthening the country's ability to use radiation techniques and provide sustainable and quality medical imaging and treatment services through trainings and fellowships. Forty-three specialists have been trained so far, and in 2019, the Government committed to the construction of a new cancer treatment centre, which will be supported by the TC programme.

In 2019, Mongolia, with the support of MON6020, 'Enhancing the Quality of Radiotherapy Through Introducing Linear Accelerator Based Advanced Technologies', inaugurated two linac machines at the National Cancer Center, enhancing its capacities to provide life-saving treatment to cancer patients.



With IAEA support, the National Cancer Center of Mongolia in Ulaanbaatar received a gamma beam radiation protection system, an X-ray calibration system and two linacs. (Photo: National Cancer Center, Mongolia)

Brunei Darussalam's 'Vision 2035 and Health Strategy' highlights the need to further develop comprehensive national radiotherapy capabilities to address the growing occurrence of cancer-related illness. The Agency is assisting the Brunei Cancer Centre – the only nuclear medicine facility in the country – to become a comprehensive cancer centre with established national radiotherapy services, by installing and commissioning treatment equipment and training staff. In 2019, support was provided through staff training, fellowships and the provision of advice through expert missions. In addition, a quality assurance system was introduced in the nuclear medicine department.

The Faculty of Medicine at the University of Latvia is the exclusive provider of the radiation protection and safety course modules in radiation therapy for radiation therapy technologists (RTTs) and therapeutic radiographers. The TC project LAT0003, 'Strengthening Knowledge and Skills in Radiotherapy Quality and Safety', helped the Faculty to develop a training infrastructure in order to provide practical training on radiation safety and quality for radiotherapy. To develop the training infrastructure, a laser system for patient positioning, a computed tomography and magnetic resonance imaging simulation software, a patient immobilization set and a treatment planning system for exclusively educational purposes were bought. The new equipment enables the faculty to provide advanced training in radiation therapy quality and patient radiation safety for practicing RTTs and radiography students, and to offer hands-on training for residents and medical physicists. In order to build capacity a two-part national training course was organized at the University in October. Forty-one RTTs and one oncology nurse received training on radiation protection, risks, radiotherapy and quality management during the first part of the course, while 50 participants including 33 radiation therapist technologists, seven medical physicists as well as five radiation oncologists and five residents in radiation oncology received training on paediatric radiotherapy during the second part.

Nicaragua's first linac radiotherapy machine was inaugurated in May in the National Centre for Radiotherapy, in close collaboration with the Ministry of Health and with bilateral funding from Japan. This is an important milestone in the treatment of cancer in the country and will allow advanced radiotherapy techniques to be performed. The Agency provided staff of the Centre with specialist training on the new system to ensure an effective transition to new 3D radiotherapy, with safe, high quality delivery of treatment.

The Agency is helping to strengthen radiotherapy capacities at the State Cancer Centre in Chihuahua, Mexico. In 2019, the Agency procured a cobalt-60 source to exchange for the



Participants at the training course organized under LAT0003 at the Faculty of Medicine at the University of Latvia, October 2019. (Photo: A. Bajinskis/Faculty of Medicine, University of Latvia)

current one, which had been in use since 2011. In addition, technical support was provided for the Centre's plans to extend radiotherapy services, including the purchase of the first public linear accelerator in Chihuahua in 2020.

NUCLEAR MEDICINE AND DIAGNOSTIC IMAGING

Professionals from 11 African Member States were trained to use Incident Learning Systems and to develop an effective safety culture during a regional training course on the Prevention of Accidents and Incidents in Nuclear Medicine, which promoted implementation of the IAEA Safety Standards and other relevant guidelines. The course was supported by RAF6051, 'Strengthening Education and Human Resources Development for Expansion and Sustainability of Nuclear Medicine Services in Africa'.

To ensure appropriate radiation protection of patients in North Macedonia, national TC project MAK6017, 'Strengthening and Improving the Quality of Positron Emission



Training course participants visit the nuclear medicine unit of the Vienna General Hospital to better understand their error- and accident-prevention schemes. (Photo: O. Pellet/IAEA)

Tomography Diagnostics of Oncological and Non-Oncological Patients with New Positron Emission Tomography Radiopharmaceuticals', has supported the Institute of Physics, Faculty of Natural Sciences and Mathematics, Skopje, in establishing a dose tracking system for medical imaging modalities. An online system with two software packages was provided to the Institute of Physics: for patient dose monitoring and for remote quality control in mammography, and 16 mammography and 19 computed tomography equipment across the country were connected to the system. In December, a national workshop took place in Skopje on the occasion of the establishment of a National Centre for Patient Dose Monitoring and Quality Assurance in Radiological Practice, attended by over 70 medical professionals. The participating hospitals confirmed their cooperation and commitment to optimize the use of this national system for monitoring of mammography image quality and patient exposure. This will contribute to establishment of national diagnostic reference levels, and to the optimization and standardization of examination protocols. This will ultimately reduce the burden on the national healthcare system, prevent unintended exposure for patients and health professionals, and improve the clinical practice and the safety culture in medical settings in the country. The first data collection and analysis are expected by the end of January 2020.

The system will be the second national system in the Europe region after Luxembourg.

Cuba successfully implemented radio-guided surgery techniques in the public health system in 2019 with the support of IAEA project CUB6027, 'Improving the Diagnosis and Treatment of Cancer by Setting Up and Strengthening Radioguided Surgery Applications'. Radio-guided surgery is a powerful technique that enables a surgeon to identify lesions or tissues that have been preoperatively marked with radioactive substances, and it has been widely used to identify the sentinel lymph node and occult lesions in patients with breast cancer.

Working with the Ministry of Health, the Agency helped Jamaica to improve access to safe, high quality services for the diagnosis and treatment of non-communicable diseases. Through project JAM6012, 'Re-Establishing Nuclear Medicine Capacity', a gamma camera (single photon emission computed tomography-computed tomography) used for diagnostic imaging and analyses of the functioning of internal organs was procured. In November, the gamma camera was successfully installed at the University Hospital of the West Indies, the only equipment of its kind in Jamaica's public sector. Furthermore, under JAM6014, 'Building Capacity for Cancer Diagnostics and Treatment Services Related to Nuclear Technologies', the IAEA provided the hospital with the necessary equipment for the safe preparation and utilization of radiopharmaceuticals, as well as staff training.



Counterparts of project MAK6017 checking patient images, Skopje, North Macedonia. (Photo: T. Furusawa/IAEA)



Single photon emission computed tomography-computed tomography installed at the University Hospital of the West Indies, Jamaica. (Photo: D. Walker/UHWI)

RADIOISOTOPES, RADIOPHARMACEUTICALS AND RADIATION TECHNOLOGY

Project RAF6054, 'Strengthening and Improving Radiopharmacy Services (AFRA)', supports human resource development in 19 AFRA States Parties in the area of radiopharmacy. Despite pressing needs for radiopharmacy training and education in Africa, particularly French speaking countries, only limited academic programmes have been available on the continent. With Agency support, Morocco established the first ever master's programme in radiopharmacy in French in Africa. Four candidates joined the programme in October 2019, some of whom will be the first radiopharmacists in their countries.

DOSIMETRY AND MEDICAL PHYSICS

A Harmonized Syllabus for Imaging Medical Physicists Training, endorsed by the States Parties to AFRA, was published in 2019 with the support of RAF6053, 'Enhancing Capacity Building of Medical Physicists to Improve Safety and Effectiveness of Medical Imaging (AFRA)'. The document is the output of several task force meetings under different AFRA regional projects in support of medical physics in radiotherapy, nuclear medicine and diagnostic radiology. It describes the minimum requirements for the academic and clinical training programmes for medical physics in radiotherapy, nuclear medicine and radiology, and presents recommendations for harmonized postgraduate academic education and clinical training of medical physicists in the region. The curriculum is already being used by the International Centre for Theoretical Physics, Trieste, Italy, where the IAEA sends fellows to be trained in medical physics every year.

Through national project UAE6007, 'Supporting Capacity Building through Education and Training Programmes for Medical Physics', the TC programme is supporting the United Arab Emirates in providing world-class healthcare services. In 2019, with IAEA support, the United Arab Emirates established a master's degree programme in medical physics at Khalifa University. This meets international standards, which state that medical physicists must obtain an MSc degree that includes a structured clinical residency programme of around two years. The establishment of the master's degree programme within the United Arab Emirates will help the country meet and maintain the required international standards.

In Kazakhstan, project KAZ6012, 'Strengthening Calibration Services at the Secondary Standard Dosimetry Laboratory', is contributing to enhanced quality and safety of diagnostic radiology services in the country by supporting improvements to the provision of calibration services. A workshop on Protection Level Calibrations Performed at Secondary Standard Dosimetry Laboratories, held in Almaty in September 2019, provided participants with an understanding of the methods used for calibration of radiation protection instruments and tools (such as ionization chambers, survey meters, contamination monitors and personnel dosimeters) and provided guidance on how to report on calibration measurements. The candidates learned how to perform calibration measurements, calculate calibration coefficients and/or calibration factors and how to assess the uncertainty budget. As other countries in Central Asia needed such a workshop, the national event 'Training on Protection Level Calibrations Performed at Secondary Standard Dosimetry Laboratories' was opened to representatives from other secondary standards dosimetry laboratories in other Central Asian countries.

Regional project RLA9085, 'Strengthening Regional Capabilities for End Users/Technical Support Organizations on Radiation Protection and Emergency Preparedness and Response in Line with IAEA Requirements', supported the Latin American Biological Dosimetry Network (LBDNet) through a three-phase training event on dicentric chromosome assay (DCA), based on the BioDoseNet Image repository databank, established on behalf of the WHO by the Federal Office for Radiation Protection (BfS), Germany, and hosted on a BfS



Positioning an ionization chamber during a practical session organized through KAZ6012. (Photo: N. Mamyrbek)

server. The exercise results demonstrated the utility of the BioDoseNet image repository as a training tool for the DCA. In these training events, cytogenetic laboratories without previous experience in biodosimetry, and unable to access suitable national radiation sources to gain familiarity with the DCA, were able to generate data to produce a dose response curve for themselves and subsequently use it to successfully estimate doses and irradiated fractions in blind samples. If the images analysed during this hypothetical exercise had been cells from real irradiated persons, the dose estimates from all labs were sufficiently accurate to allow the correct medical classification for treatment and would not have misled the clinicians; this is critical for a medical response to a radiological emergency. This finding is an international innovation, and a related LBDNet paper was accepted for publication in the International Journal of Radiation Biology in August 2019.

Supported by the same project, a representative of LBDNet participated in the Asian Radiation Dosimetry Group (ARADOS) Annual Meeting in November in Beijing where she presented the paper results. This led to numerous requests from ARADOS laboratories to have access to the BioDoseNet databank to conduct similar trainings as the ones performed by LBDNet. Additional forms of collaboration among the two regional laboratory networks were also explored.



A representative of LBDNet participated in the ARADOS Annual Meeting, 6-8 November 2019 in Beijing, leading to new forms of collaboration. (Photo: ARADOS)

NUTRITION

Nine African countries worked together under RAF6052, 'Using Nuclear Techniques to Assess Body Composition in Children Previously Treated for Moderate and Severe Acute Malnutrition and Their Medium-Term Benefits and Risks in Six Countries', to evaluate programmes for the treatment of childhood malnutrition, based on a detailed nutritional and health status assessment of children recently treated for malnutrition and long term health risks. This assessment is expected to improve national programmes treating children with moderate and severe acute malnutrition through assessment of body composition and a range of health outcomes. In 2019, participating Member States were trained on how to analyse data collected from their field work.

Food and Agriculture

REGIONAL HIGHLIGHTS

In Africa, Member States are assisted through TC national and regional projects for the peaceful applications of nuclear and related technologies in food and agriculture, with the goal of contributing to global food security and sustainable agricultural development.

In 2019, food and agriculture accounted for the highest disbursement of TC funds in Asia and the Pacific, focusing on challenges affecting food supply, safety and security in the region. TC support targeted improved crop and plant varieties using induced mutation breeding, better livestock reproduction and nutrition, enhanced control of animal and plant pests and diseases, better soil and water management, and improved food safety.

In Europe and Central Asia, livestock production was of interest to the majority of Member States in 2019. The use of nuclear and nuclear-derived technologies for pathogen detection, differentiation and characterization, practiced during various trainings for the designated counterpart laboratories, contributed to improving the preparedness and response capacities of national veterinary laboratories in early and rapid detection and timely response of veterinary services to priority vector borne diseases in the region. In addition, controlling the invasive mosquito species *Aedes* through the integration of SIT in vector control programmes became a priority for affected European countries. Member States expressed a wish to continue regional work on improving early detection and rapid response to potential outbreaks of priority animal and zoonotic diseases, and to include activities to enhance major food crop productivity and resilience to climate change.

Food and agriculture continue to play a pivotal role in the Latin America and Caribbean region, an area in which the technical cooperation programme transfers a very diverse range of techniques and applications. In 2019, countries received capacity-building in surveillance, emergency response and the integrated use of the SIT to control and eradicate pests and diseases which negatively affect agricultural productivity and sustainability. Member States obtained significant results using isotopic techniques, contributing to the increase of soil fertility and crop yields, while reducing fertilizers and thus protecting the environment. In the area of animal health, countries, with the support of the technical cooperation programme, studied the parasite infestation rate of sheep, leading to enhanced livestock breeding and higher productivity. Continued capacity building and procurement of equipment for analytical laboratories in the region facilitated the study of the impact of persistent organic pollutants on environmental quality and human health.

CROP PRODUCTION

A new drought-tolerant variety of peanut developed under SUD5037, 'Applying Nuclear Techniques to Improve Crop Productivity and Livelihood of Smallscale Farmers in Drought Prone Areas', means that Sudanese farmers in areas prone to drought will be able to improve their livelihoods and increase national exports. The new variety, released in 2018, has shown up to 27% improvement in yields while needing less water, and has the potential to double farmers' income. It was developed using nuclear techniques with the support of the Agency, in cooperation with the FAO. Sudan's Ministry of Agriculture and Forestry is now in the process of multiplying the seeds for large-scale distribution to farmers.

Following six years of work and fruitful collaboration between the Agency and agricultural institutions and organizations in the territories under the jurisdiction of the Palestinian Authority, four new mutant lines of durum wheat have been adapted to withstand harsh conditions and drought, and have been released as new Palestinian



“In Africa, Member States are assisted through TC national and regional projects for the peaceful applications of nuclear and related technologies in food and agriculture, with the goal of contributing to global food security and sustainable agricultural development.”



Scientists from Fiji, Marshall Islands, Palau, Papua New Guinea and Vanuatu participating in the two-week-long regional training course on developing climate-proof crop varieties. (Photo: M. Matijevic/IAEA)

varieties. These new varieties are expected to increase productivity by between 20 to 25% per cent more than common local varieties, and are helping improve the food security of rural communities in marginal areas.

Twelve scientists from five SIDS, Fiji, Marshall Islands, Palau, Papua New Guinea and Vanuatu, participated in a regional training course in October 2019 to strengthen their skills in developing more resilient plant varieties that will lessen the impact of climate change on food security and agriculture. The smaller geographic size of SIDS and their direct exposure to storm surges and rises in sea level mean that the effects of climate change are exacerbated. The scientists learned about the fundamental principles and practical methods for crop mutation breeding, and also gained hands-on experience in all aspects of mutation breeding, from initial detection and testing to DNA extraction and quality control.

The IAEA provided support to the Asia and the Pacific region under RAS5075, 'Sustainable Cotton Production Through Enhanced Resilience to Climate Change', which aims to build capacity in the mutation breeding of cotton plants in countries in the region. Since 2016, four mutant varieties have been released. In 2019, two mutant cotton lines were submitted to the national commission in Pakistan for official registration and releasing. Cotton varieties from Pakistan were also disseminated to Bangladesh and Myanmar.

The Agency is supporting Indonesia's efforts to implement the country's National Middle-term Development Plan 2015–2019, specifically as regards food self-sufficiency, by improving national capabilities in mutation breeding, and through a breeding programme for beef cattle improvement. Small-scale beef cattle farmers in the country have benefitted from Agency-sponsored training programmes and expert missions, and the country has been helped to establish around 40 small cattle communities with the support of IPB University. Each community has approximately 1000 beef cattle, and comprise a group of beef cattle owners who rear two to three animals. Each community is distributed around one or more villages. Scientists and students from IPB university are supporting and facilitating the farmers under this small holder community breeding scheme.

Jamaica has made significant progress in the application of induced mutation for plant breeding of native crops such as ginger and sweet yam, which are affected by diseases that lower their productivity and yield. Using nuclear techniques, new varieties are being developed that are resistant to the diseases and that produce higher yields, increasing



New varieties are selected for resistance to diseases that affect yields and productivity. (Photo: N. Schloegl/IAEA)

farmer income. The seeds are irradiated at the IAEA Laboratories at Seibersdorf, and the new varieties are tested at the Scientific Research Council of Jamaica. In 2019, the Agency supported the Scientific Research Council under JAM5013, 'Improving Crops by Using Experimental Mutagenesis and Diagnostic Technologies', with expert advice, training of staff and the procurement of an additional greenhouse for the testing of the new varieties after their selection under laboratory conditions.

In Cuba, short-cycle soybean varieties that can be harvested in 75 or 80 days have been developed by the National Institute of Agricultural Sciences with the support of project RLA5068, 'Improving Yield and Commercial Potential of Crops of Economic Importance'. The new varieties can be planted and harvested more than once a year and thus contribute to food security in the region. Six varieties are already registered in Cuba, with a further four in the registration process. In addition, one is white grain soybean, which is very useful in producing soy milk and yogurt. As well as having a short cycle, the new varieties also improve the soils in which they are grown and are resistant to abiotic and biotic stresses such as drought, salinity and high temperatures.

AGRICULTURAL WATER AND SOIL MANAGEMENT

In the region around Bangui in the Central African Republic, the project CAF5011, 'Building National Capacities for Improving the Efficiency of Biological Nitrogen Fixation for Food Security, Fertility Restoration and Rehabilitation of Degraded Soils', supported the implementation of new practices that have led to a three-fold increase in cassava yields compared to traditional farming practices. Around 300 farmers in three experimental areas were able to increase their production from 15 tons to 50 tons per hectare. These improved soil and nutrient management practices are being extended to other regions in Central Africa Republic.



Farmers at the cassava field site with the project counterpart in Central African Republic, and with some of the harvested cassava. (Photo: M. Zaman/IAEA)

LIVESTOCK PRODUCTION

The provincial laboratory network of Uganda's veterinary service has been reinforced with the support of UGA5038, 'Supporting National Animal Production and Productivity through the Establishment of Regional Animal Health Centres and Improving Disease Control at the National Animal Disease Diagnostics and Epidemiology Centre'. Enhanced capacity in the diagnosis of animal diseases has increased the number of samples analysed annually from 30 000 to over 65 000. Training provided by the IAEA has improved the knowledge and skills of the laboratory staff. Samples are no longer required to be sent abroad and local laboratory performance in proficiency tests and inter-laboratory comparison exercises has improved. In 2019, seven regional laboratories were fully established to provide diagnostic services.

In Lesotho, the Central Veterinary Laboratory has gained capacity for diagnosis of animal diseases including brucellosis, anthrax and Newcastle disease using molecular and enzyme-linked immunosorbent assay technology, supported by LES5007, 'Enhancing Livestock Production and Health'. Turn-around time has improved, reliance on other countries for disease diagnosis has been reduced, and enhanced disease surveillance for improved disease management has facilitated access to international markets in line with World Organization for Animal Health requirements. The total number of samples that are routinely received, processed and tested each month has increased by over 25 %. During 2019, the project also assisted the Central Veterinary Laboratory in strengthening its artificial insemination programme. Improved semen evaluation has led to better management of insemination programmes for small scale farming communities.

The capacity of the Nuclear Institute for Agriculture and Biology in Pakistan has been increased with the support of PAK5050, 'Developing a Facility for the Diagnosis of Transboundary Animal Diseases and Vaccine Production'. Laboratory equipment has been upgraded and the staff of the vaccine production team have been trained, enabling the laboratory to produce a higher volume of livestock vaccines with better quality control. The capabilities of the institute were enhanced to address foot-and-mouth disease and peste des petits ruminants. In 2019, the Nuclear Institute for Agriculture and Biology laboratory achieved a score of 100% in the interlaboratory test on diagnosis of peste des petits ruminants using serological methods, organized by the Agency.

The capacity of veterinary laboratories from the Europe and Central Asia region for the early detection of vector-borne diseases of animals, including those with zoonotic potential, has been enhanced with the support of RER5023, 'Enhancing National Capabilities for Early and Rapid Detection of Priority Vector Borne Diseases of Animals (Including Zoonoses) by Means of Molecular Diagnostic Tools'. In 2019, the project trained specialists on the use of

nuclear-derived techniques in the diagnosis of African swine fever, African horse sickness, bluetongue, West Nile fever, Usutu, Q fever, leishmaniasis, equine infectious anaemia and others. Diagnostic technologies for the priority vector-borne diseases were updated and adapted for implementation in the counterpart laboratories.

The project also supported the development of capacities for the collection, sorting, storage and identification of the most important vectors for vector-borne diseases. It also improved the dissemination of knowledge through the establishment of Online Open Source Standard Operation Procedures for Species Identification and Software for Priority Arthropod Vectors, as well as through training on the use of Open-Source Real Time Geo-Visualization tools in monitoring vectors and vector-borne disease. In addition, an emergency training was delivered to specialists for the detection of peste des petits ruminants in sheep and goats, as this disease is threatening the region, and has been declared by FAO as the next target for eradication. The project has contributed substantially to improving the preparedness and response capacities of national veterinary laboratories in early and rapid detection, and of veterinary services in the timely response to priority vector borne diseases in the European region, using nuclear and nuclear-derived technologies for pathogen detection, differentiation and characterization.

INSECT PEST CONTROL

The regional project RAF5080, 'Supporting Area-Wide Tsetse and Trypanosomiasis Management to Improve Livestock Productivity - Phase IV', aims to enhance the capacity of tsetse infested Member States to control tsetse flies and to assess the feasibility of including the SIT in area-wide integrated pest management programmes against the tsetse and trypanosomiasis problem. A georeferenced fly round system, which allows comprehensive surveillance of large areas with reduced efforts in terms of human and logistic resources, has been developed to monitor tsetse populations and distribution. This system has been used to map the distribution of *Glossina swynnertoni* in United Republic of Tanzania and has been transferred to several countries through expert missions (Uganda, Zambia and Zimbabwe).

The cost-efficiency of SIT technology has also been addressed. The use of unmanned light aircraft (drones) with embedded automated tsetse release machines has been validated and several countries have obtained authorization from their authorities to operate drones for tsetse control (Burkina Faso, Chad, Uganda and Zimbabwe). The project also provided support to the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) of the African Union Coordination Office. A bankable project proposal with the main goal being to accelerate the implementation of the PATTEC initiative in Africa and to develop a communication strategy as an advocacy tool to mobilize resources was developed. The developed bankable project has a budget of US \$23 million and a duration of five years.

The project SAF5014, 'Assessing the Sterile Insect Technique for Malaria Mosquitoes in a South African Setting, Phase II', is at an advanced stage of demonstrating the technical feasibility of using SIT in the field. In August 2019, the first African mosquito pilot mass rearing facility to produce and sterilize sufficient numbers of mosquitoes to support a small-scale pilot release programme was commissioned at the South African National Institute for Communicable Diseases. The project has supported the optimization of mass-rearing techniques, streamlining operations for mass production, extensive community



Training in Zimbabwe.
(Photo: R. Argiles Herrero/IAEA)

engagement in north-eastern KwaZulu-Natal, and human capacity development. The pilot release programme (250 000 sterile males/week) will begin in 2020.

With support from projects MAR5022, 'Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-Friendly Techniques to Increase Production in Different Areas, Phase II', and RAF5074, 'Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods', Mauritius inaugurated a new facility in 2019 to apply SIT to fight insects that cause annual losses of around US \$6 million to farmers. The facility will be used to produce 15 million sterile flies per week – including the three species causing the most economic harm to the island: the oriental fruit fly, the peach fruit fly and the melon fly.

Singapore expanded its capacity to suppress the urban *Aedes aegypti* mosquito population, the primary vector of dengue, chikungunya and Zika in Singapore, with the inauguration of a new mosquito production facility in December. The new facility has a ten-fold higher production capacity, with a target of five million male mosquitoes every week. The Agency provided technical assistance in various areas, including the provision of a high-throughput rearing tray system and expert assistance.

Containment treatment protocols and integrated pest management methods have been validated against peach fruit flies, *Bactrocera zonata*, with the support of ISR5021, 'Assisting in the Development of a Strategy to Counteract Bactrocera Zonata'. The peach fruit fly threatens Israel's agricultural production, as it affects over 50 fruit species including citrus, mango, peaches, and nectarines. The validated protocols have supported the containment of the peach fruit fly in Tel Aviv.

Invasive mosquito (*Aedes* species) were introduced into Europe in the late 1990s, and are now spreading rapidly, becoming a widespread and significant risk to both human and animal health because of their role as disease vectors. Since 2016, RER5022, 'Establishing Genetic Control Programmes for Aedes Invasive Mosquitoes', has helped 13 Member States to establish control programmes for invasive mosquito species in affected European countries through the integration of the sterile insect technique (SIT) in vector control programmes. Under the project, six regional trainings, four regional meetings and two expert meetings were conducted, reaching over 20 entomologists and public health professionals for each activity. Information and experience regarding effective surveillance and control and SIT pilot implementation was shared through the project, as was experience in stakeholder engagement and outreach around the SIT pilot. In addition, protocols and standard operation procedures for area-wide SIT related activities in Europe region were harmonized. Selected localities in Athens, Greece, integrated SIT into their vector control programmes in 2018, and implementation continued in 2019 as part of an area-wide integrated pest management which resulted in successful suppression of the *Aedes albopictus* population in the area. A number of localities in Albania, Montenegro and Serbia are expected to integrate SIT in their vector control programmes in 2020 and beyond.

New World screw worm (*Cochliomyia hominivorax*) (NWS) is a transboundary pest that not only jeopardizes food production, but also negatively affects wildlife and public health. Regional project RLA5075, 'Strengthening the Regional Capacities in the Prevention and Progressive Control of Screwworm', promotes the monitoring and control of the NSW in Latin America and the Caribbean to enhance productivity in livestock production while ensuring animal welfare and health public. The project provides expertise, equipment and capacity building activities in support to both, endemic and non-endemic countries. In 2019, several documents were issued within the framework of the project. The updated *Road Map for the Suppression and Eradication of the NWS* provides counterparts with a step-by-step-guide for the establishment of an integrated pest management and the progressive control of the NWS. The *Strategic Plan for the Eradication of the NWS* establishes a possible scenario for international cooperation that may lead to the eradication of the NWS from South America. The *Economic Feasibility Study for the Progressive Eradication of the New World Screwworm from South America using the Sterile Insect Technique* assesses the costs incurred

by the pest, stresses the cost-effectiveness of the SIT and provides project participating countries with a user-friendly tool for decision-making considering economic aspects. The implementation of the project strongly benefits from continued cooperation with the United States Department of Agriculture, the Commission for the Eradication and Prevention of Screwworm, as well as the FAO and the World Organisation for Animal Health.

In 2019, Cuba took a significant step forward in the control of *Aedes aegypti* mosquito with the start of the pilot release of sterile *Aedes aegypti* males. The activity is supported by project CUB5021, 'Demonstrating the Feasibility of the Sterile Insect Technique in the Control of Vectors and Pests', which aims to control the natural populations of the vector using the sterile insect technique (SIT). A communication strategy has been in place since the beginning of the project to sensitize the inhabitants of the community where insect releases will be made to the benefits and advantages of the technique. The first mosquito release was made by children from primary schools in the community 'El Cano', attended by local leaders, municipal government authorities, senior officials of the Ministry of Public Health, and the representative of the Pan American Health Office in Cuba.



School children participate in the pilot release of sterile mosquito as part of the communication strategy of project CUB5021.

(Photo: Agency for Nuclear Energy and Advanced Technologies, Cuba)

FOOD SAFETY

With the support of project UGA5040, 'Strengthening Multi-Sectoral Food Contaminant Monitoring Programmes Through the Effective Use of Nuclear, Isotopic and Complementary Techniques', Ugandan scientists are now able to carry out independent sampling and testing of various foodstuffs in the country, allowing Government authorities to determine exposure to contaminated food in a timely manner, and thus prevent the spread of food safety hazards and contain food safety emergencies. In 2019, institutions which benefitted from IAEA support joined forces with other stakeholders and were able to investigate and address an outbreak of food poisoning that followed the consumption of a fortified food that had been distributed as part of a relief programme. Analytical capabilities have been enhanced and new skills developed with the support from the IAEA in cooperation with the FAO, at the country's main laboratories: the Uganda National Bureau of Standards and the Directorate of Government Analytical Laboratory.

In Botswana, the capacities of the national network of laboratories, including Botswana National Veterinary Laboratory (BNVL), the Division of Plant Protection (DPP) and the

National Food Control Laboratory (NFCL), have been strengthened with the support of BOT5017, 'Enhancing Capabilities for Inter-institutional Monitoring of Chemical Food Contaminants Using Nuclear/Isotopic and Complementary Analytical Techniques'. The laboratories have received a wide range of sophisticated analytical instrumentation and appropriate training for their staff, and the BNVL is now accredited up to the standard of ISO 17025:2005 and is currently moving towards ISO 17025:2017 accreditation. Several analytical techniques have been accredited with 17 used for testing food exports and local monitoring programmes for over 60 residues or contaminants. During 2019, five more methods were in the process of accreditation, and the annual number of analyses grew to more than 6000 for beef, dairy and feed samples– including over 4000 milk samples. The NFCL analyses over 5000 samples under the national Vulnerable Groups and School Supplementary Feeding Programmes. New capacity at the DPP has enabled the institution to implement national pesticide control legislation.



Laboratory staff using equipment procured through the project, after undertaking training to enhance analytical capabilities. (Photo: BNVL)

The Agency has supported the upgrade of the Central Food Laboratory in Qatar through projects QAT5004, 'Upgrading the Central Food Laboratory', and QAT5005, 'Upgrading the Central Food Laboratory Phase II'. The projects aimed to ensure the safety of foodstuffs and drinking water by building capacity to monitor levels of Alpha/Beta contaminants. Under the projects, a radiochemistry separation laboratory was established with equipment and human resources were developed. In 2019, through IAEA support, the Central Foods Laboratory became the first laboratory in Qatar to obtain the accreditation of ISO 17025:2005 for Gamma measurements.

In Bulgaria, climate change and related drought stress has led to the abandonment of crop lands as they become too arid. Drought stress is a major factor limiting yield and yield stability of the crops, but plant biodiversity can help address unfavourable environmental conditions. The project BUL5015, 'Increasing Productivity and Quality of Basic Food Crops', focused on the development of drought tolerant mutant lines of targeted crops (potato and pepper). Specialized laboratory equipment and consumables were delivered to the counterpart institution, three expert missions were organized to advise on drought tolerance, and several laboratory staff members enhanced their skills and knowledge abroad through four scientific visits and four fellowships. As a result, the technology of proteome analysis was introduced for the first time in Bulgaria in 2019.

Water and the Environment

REGIONAL HIGHLIGHTS

In Africa, the IAEA supports efforts to integrate the use of isotope hydrology into national water infrastructure and programmes – especially for the characterization and monitoring of groundwater. The IAEA Water Availability Enhancement (IWAVE) methodology has been carried out in five countries in the Sahel region – Benin, Cameroon, Ghana, Niger and Nigeria.

In Asia and the Pacific, IAEA technical cooperation projects help Member States apply isotope techniques to manage their water resources effectively. The projects also promote the use of isotopic techniques to identify and study the sources, extent, quality, interactions and transport of the water cycle. Other projects help Member States measure pollutants and environmental radioactivity in the air, land and oceans, and support the ability of countries to manage and protect marine resources and coastal zones.

Member States in Europe and Central Asia have been prioritizing the generation of harmonized data on the environment to support evidence-based policy making for environmental protection and enhanced quality of life. The Agency has supported several national and regional projects on the management of air pollution, groundwater resources, uranium legacy sites, and the assessment of the impact of climate changes on land-water-ecosystem interactions. This cooperation has led to the establishment of a network of laboratories and research centres working on air, soil, freshwater, marine and coastal issues in the region. Agency capacity building and support to these centres and laboratories has enhanced monitoring capacities in the region, leading to the production of comparable scientific data, enhanced knowledge sharing, and better coordinated collaboration and research.

As countries in Latin America and the Caribbean face the impacts of climate change, nuclear techniques related to the management of water resources and environment have become essential in climate change monitoring and adaptation. Technical cooperation projects in 2019 enabled Member States to better manage freshwater resources with the support of isotope hydrology. As monitoring of the marine environment is essential for many countries of the region that depend on the sea to survive, the Agency supported the establishment of a regional observatory in ocean acidification. In addition, regional reference centres for the detection of toxins have been established in several countries in the region, and monitoring programmes on microplastics and other marine stressors, with harmonized protocols, have been set in place in participating Member States.

WATER RESOURCE MANAGEMENT

The United Republic of Tanzania received support to strengthen the National Isotope Hydrology Laboratory under URT7002, 'Building Capacity to Assess and Monitor Water Resources Using Isotope Hydrology Techniques'. The stable isotope laboratory, equipped through joint IAEA and government funding, now has a liquid isotope water analyser and associated consumables, ion chromatography for chemical analysis, a deionizer-water system and field equipment for sampling. In tandem with the equipment support, which included installation and calibration, a range of human capacity building activities such as fellowships, scientific visits and expert services were delivered to boost the expertise of the laboratory staff to design and conduct field sampling campaigns, and to produce good quality analytical results. The stable isotope laboratory is now functional and accessible to national stakeholders needing to carry out routine isotope and chemical analysis.



“As countries in Latin America and the Caribbean face the impacts of climate change, nuclear techniques related to the management of water resources and environment have become essential in climate change monitoring and adaptation.”

In the Philippines, the TC programme supported the conduct of a nationwide assessment of groundwater resources in critical areas using nuclear and isotope techniques. The results from this study are now being integrated in the National Water Resources Board policy on national water resources assessment.

With ongoing support from the national projects KUW7004, 'Managing Groundwater Resources Using Stable and Radioactive Isotopes', and KUW7006, 'Assessing Submarine Groundwater Discharge Along the Coastal Area Using Radioisotopes', among others, the Water Research Center of the Kuwait Institute for Scientific Research is now capable of carrying out studies on a range of groundwater issues and can provide services for large multi-disciplinary water projects. The staff of the Centre have developed skills in a range of disciplines, including hydrogeology, hydrochemistry, mathematical modelling, water chemical and isotopic analysis, water sampling from wells and surface water bodies, and aquifer tests. Numerous groundwater investigation studies have been carried out, generating extensive useful environmental isotopic data on Kuwait groundwater and helping to tailor effective water management strategies in Kuwait.

Following participation in the IWAVE Project, which aims to support Member States in conducting rigorous, science-based assessments of their national water resources, four pilot countries in Latin America (Plurinational State of Bolivia, Colombia, Mexico, and Paraguay) have carried out ground, surface and rainwater sampling campaigns and have produced piezometric, hydro chemical and isotopic data. The hydrological data obtained was key to advancing understanding of hydrogeological conditions and the formulation of conceptual models in priority areas in each country. In addition, under regional project RLA7024, 'Integrating Isotope Hydrology in National Comprehensive Water Resources Assessments', 18 Member States from the region participated in regional training courses on Isotope-Enabled Water Balance Modelling in the Context of Climate Change (Paraguay, July 2019) and on the Use of Isotope Techniques for Groundwater Dating (Cuernavaca, Mexico, September 2019). A number of regional reference laboratories in Argentina, Brazil and Mexico are in the process of strengthening their analytical capacities in low-level tritium analysis of water samples; while in Brazil, Colombia and Costa Rica capacities are being enhanced in stable isotope analysis of water samples. These laboratories will support national and regional institutions providing quality isotope analysis.

The Central America Dry Corridor (CADC), a tropical dry forest region on the Pacific domain that extends from Chiapas (Mexico) to the western part of Costa Rica and western provinces of Panama is home to approximately 3.5 million people. The CADC depends heavily on groundwater as a primary water resource, due to the decline in quality and quantity of surface water resources. A better understanding of the factors that control rainfall patterns and the linkages to groundwater recharge and surface discharge is imperative for Central American Member States to improve resource allocation and conservation efforts in nationwide water management plans. Regional project RLA7024, 'Integrating Isotope Hydrology in National Comprehensive Water Resources Assessments', also provided assistance to Member States from this region in 2019 – Costa Rica, El Salvador, Honduras, Nicaragua and Panama – to improve groundwater/surface water monitoring in the CADC, with the goal of producing up to date hydrological information for stakeholders and policy makers and contributing to the prioritization of conservation measures in related watersheds.

MARINE, TERRESTRIAL AND COASTAL ENVIRONMENTS

The IAEA has assisted 22 coastal African countries to establish, develop or strengthen marine coastal monitoring programmes through regional projects, the latest of which is RAF7015, 'Strengthening Regional Capacities for Marine Risk Assessment Using Nuclear and Related Techniques'. The project has enhanced national capacities for measuring pollution of radionuclides and toxic metals, which enabled the counties to establish a consolidated baseline database for pollution monitoring along the African coast in 2019.

The database, the first of its kind, is composed of quality-assured measurements for polonium-210, cadmium, lead and mercury in biota and in surficial sediments collected along the coasts of 14 African countries during a joint, harmonized survey campaign. This data set will be published in a peer-reviewed scientific journal and will be provided to national authorities to support decision-making processes related to future initiatives on protection, management and conservation of marine coastal resources.

RER7009, 'Enhancing Coastal Management in the Adriatic and the Black Sea by Using Nuclear Analytical Techniques', aims to harmonize the capacities of Member States to monitor and observe changes in the quality of coastal sediments on a regional scale, taking into consideration aspects of pollution and climate change, using nuclear analytical techniques. The project has enabled the formation of a strong collaborative network of analytical laboratories and experts in the participating countries, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Montenegro, Romania, Russian Federation, Slovenia, Turkey and Ukraine, who share resources and knowledge. In October, a workshop in Kotor, Montenegro, allowed participating countries to present their data, which was then compiled into a preliminary regional database of sediments in the Adriatic and the Black Sea. The workshop included a one-day sampling training on the collection, slicing and preservation of sediment cores from the Adriatic Sea, the results of which were included in the preliminary database. The database is expected to support comparison and assessment of how marine processes respond to pollution and climate changes in closed and semi-closed seas, and to assist decision makers to develop sediment quality standards and to produce measures to ensure that existing levels of contamination in sediments will not increase significantly.

With the support of preceding projects, significant results have been consolidated under RLA7022, 'Strengthening Regional Monitoring and Response for Sustainable Marine and Coastal Environments (ARCAL CXLV)'. A regional observatory that monitors ocean acidification on a monthly basis was established, with stations in Colombia, Costa Rica, Cuba and Mexico. In addition, regional reference centres for the detection of toxins have been established in Colombia, Cuba and El Salvador. Monitoring programmes on microplastics and other marine stressors have been set in place in participating Member States, with harmonized protocols. Scientific data produced in relevant areas of ocean acidification, harmful algal blooms and other marine stressors have been archived into existing marine databases, such as for example the Harmful Algal Event Database for harmful algal bloom events. In addition, the project supported the creation of a knowledge management web platform that makes the data accessible to the network members, the scientific community, decision makers and the public in general.



Sediment core taken from the Mediterranean coast during the sampling expedition organized within a project workshop that took place in Kotor, Montenegro, October 2019. (Photo: J. Obhodas/ Ruđer Bošković Institute)



Mollusc mortality in Union Bay in El Salvador, November 2019, followed by collection of molluscs for analysis for paralyzing toxins using the receptor binding assay technique (Photo: SECOM-UES)

Three unmanned environmental monitoring stations to detect and measure radiation from soil and air were inaugurated in Paraguay in 2019, which will enable the staff of the national Radiological and Nuclear Regulatory Authority (ARRN) to develop national baseline data on naturally occurring radiation. Based on this data, any type of alteration in these values can be identified. One station was installed in the capital, Asunción, and the other two in Pilar and Alberdi. Training provided by the IAEA has prepared experts to not only measure radiation levels, but also identify the sources responsible for the radiation. The new stations significantly increase the country’s ability to differentiate natural radiation from others generated by radiation sources, such as radiation from an accidental release or a lost source. The IAEA has also provided a laboratory in Paraguay with a liquid scintillation analyser to allow scientists to analyse radiation levels in water, sediments and food samples, complementing the environmental monitoring stations. Scientists from the Multidisciplinary Centre of Technological Research at the National University of Asunción have been trained to use the new equipment and interpret the results, which will help widen the scope of their research. The support has been provided under national project PAR9006, ‘Monitoring Variations in the Levels of Ionizing Radiation’.



The environmental monitoring stations were inaugurated in 2019. (Photo: ARRN)

Industrial Applications

REGIONAL HIGHLIGHTS

The TC programme in Africa assists Member States with capacity-building, research and development in nuclear science through its national and regional projects, and supports them in using nuclear technology in a variety of practical industrial applications.

In Asia and the Pacific, the TC programme works to enhance national capacities in the industrial applications of radioisotopes and radiation technology. Technical cooperation projects provide advice, assistance and capacity building support to Member States in the region in the use of irradiation facilities and electron beams, as well as x-ray technology, for varied applications, including tracking pollutants, treatment of wastewater, sterilization of medical products, disinfestation of food grains, carbon dating and the preservation of cultural heritage artefacts.

Radiation technology plays an important role in Europe, and is applied in industry to conserve the environment and to promote efficient use of resources. Through several national and regional projects, the Agency has supported country efforts to increase capacity in the safe and efficient use of radiation processing. In addition, the technical cooperation programme supported the implementation of radiation technologies in other fields, such as pollution control and detection, and research into nanomaterials for biomedical and industrial applications, as well as the synthesis and modification of polymeric materials. The characterization and preservation of cultural heritage artefacts continues to be a priority area for many countries in the region. Agency support and extensive technical support by Nucléart Regional Conservation Workshop, French Alternative Energies and Atomic Energy Commission, Grenoble, France, has led to the increase in the number and types of cultural heritage artefacts analysed and treated in the region over the last 10 years. This is also thanks to excellent collaboration and understanding of the use of nuclear technology among the local scientists and the professionals from libraries and museums.

Promoting the competitiveness of regional industries with a focus on sustainability is of great importance for the development of the Latin America and the Caribbean region. The Agency supports the development of capacity for the application of nuclear technologies in mining, metallurgical and oil industries, agro-industries, food industries and wastewater treatment companies. Support for the application of non-destructive testing techniques to inspect and certify the integrity of civil structures as well as industrial process is also important to the region.



“Radiation technology continues to play an important role in Europe, and is applied in industry to conserve the environment and to promote efficient use of resources.”

RADIOISOTOPES AND RADIATION TECHNOLOGY FOR INDUSTRIAL APPLICATIONS

The IAEA has helped Thailand to undertake different research and development studies in production of bioplastics, conservation of cultural heritage, processing of biological and gemmological samples and production of radiopharmaceuticals. Support from technical cooperation projects, including THA1011, ‘Strengthening Capacities for Multipurpose Radiation Technologies in Material Applications’, and THA1012, ‘Supporting Development of a Multipurpose Research Reactor’, has played a significant role in the development of a national patent which can potentially enhance radiation processing for polymer modification in the country. In 2019, the Agency provided support for the establishment of the Synchrotron Light Research Institute (SLRI-ASEAN Beamline), which is already providing unique opportunities for research and innovation in the area of industrial applications for the entire region. Thailand has furthermore decided to invest in the establishment of the 30 MeV cyclotron facility at the Thailand Institute of Nuclear Technology. The new 30 MeV

cyclotron will be able to produce both single photon emission computed tomography and positron emission tomography radionuclides with a suitable half-life for shipping within Thailand and to the Association of Southeast Asian Nations countries.

Sri Lanka has received support from the Agency in promoting nuclear technologies, particularly non-destructive testing techniques, for use in industrial applications. Through the TC project SRL1009, 'Strengthening the National Centre for Non-destructive Testing', the National Centre is now able to provide training and comprehensive services in advanced non-destructive testing techniques.

The Philippines is currently expanding the capacity of its gamma irradiation facility to meet the growing demand from industry for various purposes, including sterilisation of disposable medical and surgical products, and decontamination of food items such as spices, dried vegetables and health supplements. The Agency provided support to the country in the development of a full-automation system and the procurement of new Co-60 sources to enhance the throughput and safety of the irradiation facility through projects PHI1019, 'Enhancing the Safety and Throughput of the Gamma Irradiation Facility Through Full Automation', and PHI1020, 'Enhancing the Utilization of the Fully Automated Philippine Nuclear Research Institute Gamma Irradiation Facility'. In 2019, the Irradiation Services Team of the Department of Science and Technology, Philippine Nuclear Research Institute received the Presidential Lingkod Bayan Award for their outstanding contribution to the country's nuclear research programme, and the industrial application of irradiation technology.

Over the last few decades, increased trade within the European Union (EU), and between the European Union and other European countries and regions worldwide has brought a strong need to ensure the trade of safe radiation processed products, and harmonization of quality control methods in line with international standards. RER1019, 'Enhancing Standardized Radiation Technologies and Quality Control Procedures for Human Health, Safety, Cleaner Environment and Advanced Materials', has supported 22 countries' efforts to harmonize regulations and promote ISO standards in introduction, fabrication and testing. A dosimetry inter-comparison exercise among 15 Member States was performed in 2018–2019, offering a peer review of quality assurance/quality control practices in gamma and e-beam facilities, with the Centre for Radiation Research and Technology, Institute of Nuclear Chemistry and Technology, Warsaw, Poland (an IAEA Collaborating Centre), as the leading institution. The participating laboratories reviewed, updated, and harmonized their standard physical and chemical methods. In February 2019, the integrated laboratory for multiple radiation applications at the Faculty of Electrical Engineering and Information Technologies (FEEIT), Ss.Cyril and Methodius University, in Skopje (UKIM), North Macedonia, received accreditation as a laboratory for the detection of irradiated food, with standard physical methods (MKC-EN ISO/IEC 17025:2006), the first and only institution in North Macedonia. Subsequently, the integrated laboratory launched a monitoring programme for detection of irradiated food with the Food and Veterinary Agency, in 2018 and 2019.

MAT1001, 'Training and Upgrading of Technical Capabilities for Scientific Application in the Field of Cultural Heritage', supported the upgrade of the Heritage Malta Diagnostic Science Laboratory (DSL). An expert visit in 2019 was conducted to train DSL staff in recent advancements of X-ray diffraction (XRD) in preparation for the possible future procurement of such a system. The knowledge transfer initiative covered aspects of theory, hardware, software, qualitative and quantitative analysis, advantages, limitations, complementarity strengths and several case studies. A specific highlight on micro-X-ray diffraction was also made, given the importance of small sample size recovery/availability in the cultural heritage sector. A portable X-ray diffraction was also brought over to Malta for analysis demonstrations.

In the Latin America and Caribbean region, capabilities have been developed for the application of nuclear technologies in mining, metallurgy, oil industries, agro-industries, food industries and wastewater treatment companies. The project RLA1013 'Creating



A practical session using a portable XRD to showcase non-invasive applications as part of MAT1001. (Photo: M. Grima/Heritage Malta)

Expertise in the Use of Radiation Technology for Improving Industrial Performance, Developing New Materials and Products, and Reducing the Environmental Impact of the Industry (ARCAL CXLVI), allowed national counterparts to improve the usage of renewable resources and economic competitiveness. With the support of RLA1013 and the national project PAN1001, 'Investigating Sediment Transport in the Panama Canal Basin Using Tracers', nuclear technology was used to characterize the dynamics of sediment transport in the Panama Canal watershed. In November 2019, several experiments using a nucleonic gauge were carried out jointly with the Panama Canal Authority (ACP). The nucleonic gauge allows the localization of the mixture water-sediment layer and thus the determination of navigable depth. This supports ecological safety through the optimization of dredging works. The IAEA provided technical support and training during the tests, and some 40 ACP engineers and specialists participated in this capacity building activity.

Cuban experts installed radioactive sources in 2019 at the country's long-dormant Food Irradiation Plant, reviving food irradiation services in the country with the support of project CUB1012, 'Enhancing Irradiation Services'. As a method for preservation, food irradiation technology offers a safe and sterile alternative to conventional techniques such as heating, freezing and refrigeration or treatment of the food with chemicals. The Food Irradiation Plant is now a multi-purpose irradiation facility which can also provide a number of new



Study site: Panama Canal Atlantic site, Colón, Panama. (Photo: ACP/ Dredging Division). Right: IAEA Technical Officer and ACP collaborators collecting data from the nucleonic gauge measurements. (Photo: Center for Hydraulic and Hydrotechnical Research.)



Plant operators work in the newly-inaugurated Food Irradiation Plant.
(Photo: M. Klingenboeck/IAEA)

services beyond food irradiation. These services, provided on an on-demand basis, are expected to include industrial processing, radiation-sterilization and decontamination services, the treatment of persistent pollutants and the production of medical ‘smart materials,’ such as hydrogel dressing. The reinstatement of Cuba’s food irradiation capacities is also expected to increase import substitution, increasing food security and reducing the costs associated with importation.

RESEARCH REACTORS

Following a request from the Nigeria Atomic Energy Commission, the Agency conducted an Integrated Safety Assessment of Research Reactors mission to the Nigeria Research Reactor-1 research reactor in Zaria, Nigeria, in

August 2019. The mission reviewed the operational safety and commissioning results of Nigeria Research Reactor-1 after the core conversion from high enriched uranium to low enriched uranium fuel and made recommendations for safety improvements in various organizational and technical areas, including the need to update safety documentation and operating programmes.

A Project Coordination Meeting for project RAF1007, ‘Strengthening the Capacities of Research Reactors for Safety and Utilization (AFRA)’, took place in Rabat, Morocco, in July 2019. The meeting reviewed the safety and utilization activities of research reactors conducted under the regional project, discussed the reports from the project scientific consultants and Member States, and identified issues and challenges related to the implementation of the project as well as actions to address them.

Also, under RAF1007, Member States were trained in the expansion of radioisotope production in Africa. Morocco hot commissioned Iodine-131 radioisotope production, and the operating procedures were completed. Egypt established the safety documentation for in-core irradiation of Iridium-192 in 2019, and is supplying Molybdenum-99/Technetium-99m generators to 64 Egyptian hospital and medical centres.

In addition, assistance was provided to support the development of e-learning tools in research reactor utilization, namely the IAEA E-learning Course on Neutron Activation Analysis, which was reviewed by 10 professionals from African Member States in 2018. In 2019, the course was used by professionals from 12 African Member States, including all those with operating research reactors and several embarking countries.

In 2019, the IAEA continued to support Jordan in enhancing utilization of the Jordan Research and Training Reactor under the national project JOR1008, ‘Enhancing Capacity Building Towards Safe and Effective Operations and Utilization of the Research and Training Reactor’. The first production of Iodine-131 at the Jordan Research and Training Reactor was established and certified, and equipment and expertise were provided to set up the quality assurance system, which adheres to good manufacturing practice and ISO standards.

Several Member States in Europe and Central Asia operate research reactors that are under-utilized and are facing significant budgetary challenges. New research reactors are also being proposed within the region, and it is important that these reactors develop an adequate stakeholder base to avoid future under-utilization and budgetary shortfalls. The regional project RER1016, ‘Enhancing Utilization and Safety of Research Reactors’, supported proficiency testing by interlaboratory comparison. Fifteen European and Central Asian laboratories operating activation analysis techniques participated in the test – the largest regional contribution worldwide. Participants shared measurement results and answered an extensive questionnaire on analytical practice and experimental conditions. The exercise has enabled research reactor operators to strategize their development, in order to foster utilization of the facilities in the coming years.

Energy Planning and Nuclear Power

REGIONAL HIGHLIGHTS

In Africa, assistance is provided to develop local capacities in energy planning, analysis and knowledge management. The goal is to contribute to sustainable nuclear energy development by supporting existing and new nuclear programmes in Africa.

In the Asia and the Pacific region, a number of countries are embarking on nuclear power programmes, including Bangladesh, Indonesia, Jordan, the Philippines, Saudi Arabia, Thailand, United Arab Emirates and Viet Nam, and the region also has the highest number of reactors under construction for the expansion of nuclear energy for power generation. The Agency is supporting the development of national infrastructure for several Member States using the IAEA Milestones approach, including in the United Arab Emirates, which has plans to operationalize the first of four units of the Barakah nuclear power plant in 2020.

Countries in Europe and Central Asia operate the largest fleet of nuclear power plants (NPPs) in the world, supplying clean and reliable electricity to millions of businesses and households. Many of the operating NPPs have already reached the end of their nominal design life or will do so in the near future. Lifetime extension for long term operation, including such issues as ageing management, component resource evaluation and reliability, and the introduction of modern instrumentation and control systems is, therefore, a top priority in the region. Looking ahead, countries in the region that plan to initiate or to expand their nuclear energy programmes have asked the Agency to help increase their capacity to make knowledgeable decisions on small modular reactors commercially available for near term deployment. National and regional TC projects in Europe and Central Asia are providing training and assistance to ensure continuity of excellence in the performance of NPPs, as well as knowledgeable consideration of future nuclear power technologies as part of clean and carbon-low electricity generation capacity.

The Latin America and the Caribbean region faces growing energy demands and countries have identified the comprehensive analysis of energy supply and demand scenarios as a priority. The Agency is supporting the formulation of plans for sustainable energy development at a subregional level. The continued use of nuclear power in the region is also a priority. Aging nuclear power infrastructure requires support to keep human resource capacity at sustainable levels, and new tools are required to maintain nuclear power infrastructure operating correctly and safely.

ENERGY PLANNING

During 2019, under project RAF2010, 'Developing, Expanding and Reinforcing Energy Planning Capabilities including Nuclear Power (AFRA)', meetings of national experts were organized to finalize reports on sustainable electricity supply options for two sub-regions: northern and eastern Africa. These activities, together with a similar exercise previously performed in western Africa, are the culmination of a comprehensive capacity building programme carried out since 2014, focusing on the development of techno-economic analyses for African sub-regions by applying the IAEA's energy system assessment tools.

The Togo Electrification Master Plan was developed in 2019 with the support of TOG2001, 'Strengthening and Building Capacity on Energy Planning Using IAEA Tools'. A wide range of integrated IAEA modelling tools benefited the national team, which was made up of different national stakeholders including the Ministry of Mines and Energy, the Electricity Regulatory Authority, and the Togo Electricity company.



“The Latin America and the Caribbean region faces growing energy demands and countries have identified the comprehensive analysis of energy supply and demand scenarios as a priority.”

In Botswana, under project BOT2001, ‘Developing Scenario Modelling on Different Energy Sources for Sustainable Energy Development’, the IAEA has helped the Ministry of Mineral Resources, Green Technology and Energy Security to develop an Integrated Resource Plan. The concept of integrated energy planning and developing an Integrated Resource Plan are central to the planning process in Botswana, as guided by the national development plans. Currently, the country is implementing national development plan 11 for the period 2017–2023. In the energy sector, the national development plan focuses on increasing energy self-reliance. The national team were assisted to consider various scenarios in developing demand and supply models.

Countries in Latin America and the Caribbean have prioritized the comprehensive analysis of energy supply and demand scenarios, and in response, the Agency launched the regional technical cooperation project RLA2016, ‘Supporting Formulation of Plans for Sustainable Energy Development at a Sub regional Level - Stage II (ARCAL CLIII)’ in 2018. Over the past two years, 210 experts in 15 countries have been trained in the use of the Agency’s energy planning tools and methodologies. Following this training, participating experts across the region have developed three sub-regional studies on energy demand and two sub-regional studies on energy supply using the Agency’s Model for Analysis of Energy Demand (MAED) and its Model for Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE). With the benefit of new data on energy production, distribution and consumption throughout the region, the project counterparts were able to identify opportunities to increase efficiencies and promote sustainable energy sources through greater cross-border transmission and integration, and to examine how energy, environmental and social policies outlined in each national energy plan aligned with the achievement of broader sustainable development and climate change mitigation goals throughout Latin America and the Caribbean.



Working towards sub-regional energy integration: 20 participants from 13 Member States in Latin America and the Caribbean attended a five-day project coordination meeting. (Photo: O. Yusuf/IAEA)

INTRODUCTION OF NUCLEAR POWER

The United Arab Emirates made the decision to embark on a nuclear power programme in 2008, becoming the first ‘newcomer’ country in 27 years to start constructing its first reactor in 2012. In 2013, the United Arab Emirates and the Agency signed an Integrated Work Plan (IWP) for the period 2013–2017, which was later extended until the end of 2019 to support the implementation of the national nuclear power programme. The United Arab Emirate’s nuclear power infrastructure, developed according to the IAEA Milestones approach, has undergone continuous review by the IAEA through several peer

review missions. In September 2019, under the IWP, a team of experts concluded a five-day mission to review the emergency preparedness and response framework for nuclear and radiological emergencies in the United Arab Emirates. The Emergency Preparedness Review (EPREV) was carried out at the request of the United Arab Emirates Government, and follows an initial EPREV mission in 2015. The year 2019 marks the finalization of the IWP.

The United Arab Emirates' feedback and experience in implementing the IWP has proven to be of great interest to other Member States who are interested in embarking on a new nuclear programme, especially in the Asia and the Pacific region. In late 2019, the United Arab Emirates' Khalifa University of Science and Technology, an IAEA Collaborating Centre, hosted a training course on the IAEA Milestones approach for developing a sustainable nuclear power programme. The course was attended by 28 junior and mid-career professionals from 19 countries considering nuclear power or preparing for its introduction. Participants were trained under the framework of the interregional project INT2018, 'Supporting Knowledgeable Decision-making and Building Capacities to Start and Implement Nuclear Power Programmes'.

The Agency has been providing assistance to Bangladesh since the country first expressed interest in embarking on a nuclear power programme, through technical cooperation projects BGD2015, 'Developing a Structured Licensing Programme for the Effective Regulatory Oversight of a Nuclear Power Plant During the Construction Phase', and BGD2016, 'Developing Infrastructure and Support Systems for a Nuclear Power Plant During the Various Stages of Construction'. Agency support has included assistance with reviewing nuclear laws, preparing for adherence to international legal instruments, developing and reviewing regulations, assessing sites and developing a radioactive waste management system. In December 2019, the country completed the review of its IWP, which includes activities to address priority infrastructure issues during the construction phase of a nuclear power plant that will be carried out during the 2020–2021 programme cycle.

The Philippines is rejuvenating its effort to develop nuclear energy to meet the growing demand for electricity in the country. With Agency support through PHI2011, 'Assessing the Development of a Nuclear Power Programme', and PHI2012, 'Developing Nuclear



Bangladesh's nuclear power plant, being built in Rooppur, about 160 kilometers northwest of the capital, will have the capacity to generate 2400 megawatts of electricity. (Photo: L. Gil/IAEA)

Power Infrastructure in the Philippines - Phase II', the country completed its energy studies, which includes the contribution of nuclear power to its overall energy plan. The country received an Integrated Nuclear Infrastructure Review mission in December 2018, the report of which was completed and handed over to the Government of the Philippines in October 2019. In November 2019, the Philippines completed its first IWP to coordinate the effort to conduct the necessary follow up actions of the Integrated Nuclear Infrastructure Review mission's recommendations.

Under IRA2013, 'Enhancing the Level of Operational Safety and Reliability of the Bushehr Nuclear Power Plant-1 (BNPP-1)', operators of the BNPP-1 in the Islamic Republic of Iran increased their understanding of the nuclear and radiological emergency preparedness and response framework. This facilitates the effective implementation and coordination of sustainable emergency preparedness and response activities, including the establishment of a Corporate Emergency Control Centre.

Saudi Arabia developed an IWP for nuclear infrastructure based on the IAEA's milestone approach. The first review meeting of the IWP, held in January 2019, reviewed the progress made in 19 key areas related to the nuclear infrastructure in the country. The project SAU2009, 'Developing the Infrastructure for the Nuclear Power Programme', provided assistance to address the gaps identified in the review, and strengthened national capacity to overcome challenges and meet requirements.

NUCLEAR POWER REACTORS

With 48 nuclear power reactors in operation and nine under construction, China continues to strengthen its national nuclear safety and security, its emergency preparedness and response infrastructures, and receives expert advice for strengthening its radioactive waste management programme. In 2019, the China Atomic Energy Authority, through its State Nuclear Security Technology Centre and the China Institute of Atomic Energy, was designated as an IAEA Collaborating Centre, enabling China to provide training and support to IAEA Member States. Under TC project CPR2015, 'Supporting Techniques for Field Experiments in an Underground Research Laboratory and Performance Assessment of High-Level Radioactive Waste Disposal', China's first underground research laboratory finalized analysis and plans for a deep geological disposal site for high-level radioactive waste at Beishan, north-west China.

In Europe, six group activities including regional workshops and other training events were conducted in 2019 under regional project RER2015, 'Strengthening Nuclear Power Plant Lifetime Management for Long Term Operation'. The events provided an international forum for discussing and sharing practical aspects and experiences in the application of modern instrumentation and control systems and equipment at nuclear power plants. A number of important aspects were covered, such as passive components resource evaluation, justification of active components reliability through maintenance effectiveness monitoring, and equipment qualification issues. In one event, participants from 14 Member States attended an Eastern-European regional workshop on 'Practical Experiences with the Application of Digital Instrumentation and Control Systems and Equipment at Nuclear Power Plants' in November 2019 in Bucharest, Romania. The workshop provided participants with information on the use of commercial instrumentation and control components in NPP safety applications, computer security for nuclear instrumentation and control systems, accident and post-accident monitoring systems, and diverse safety actuation systems. Participants shared information on their national operational experiences, long term operation status, ageing management and license renewal activities.

In Armenia, the Agency is supporting the operational safety and lifetime extension of the Armenian nuclear power plant unit 2 in accordance with international standards through project ARM2004, 'Enhancing Operational Safety for Lifetime Extension of the Nuclear Power Plant Unit 2 in Accordance with International Standards'. A Safety Aspects



ARM2004 working session of the expert mission on knowledge management at the ANPP, Yerevan, Armenia, November 2019. (Photo: M. Ovanes/IAEA)

of Long Term Operation (SALTO) peer review mission was conducted in November 2018 to evaluate the programmes and performance of the plant on the basis of the IAEA's Safety Standards and other guidance documents. A follow up meeting took place in April 2019 in Vienna, and an action plan was developed to address the SALTO findings in order to reach compliance with the licensing renewal procedure. The project also supported the development of competencies and a knowledge management programme for the Armenian nuclear power plant (ANPP).

A number of European Member States that plan to initiate or to expand their nuclear energy programmes have asked the IAEA to help increase their capacity to make knowledgeable decisions on small modular reactors commercially available for near term deployment. Under RER2014, 'Facilitating Capacity Building for Small Modular Reactors: Technology Developments, Safety Assessment, Licensing and Utilization', the Agency has provided support to 16 countries in Europe. Over the past two years, 11 meetings and workshops with over 200 participants have been organized, which facilitated the exchange of experience on various aspects of small modular reactors including their design, economic and financing, non-electric applications, safety, safety assessment, principles for emergency preparedness and response as well as regulatory framework and licensing issues.

NUCLEAR FUEL CYCLE

Sustainable uranium production is critically important for secure, socially accepted uranium fuel security, notably in nuclear 'newcomer' countries, some of which are looking to source fuel from their own uranium resources. Under EGY2016, 'Supporting a Feasibility Study for Uranium and Rare-Earth Element Recovery from Unconventional Resources', RAF2012, 'Enhancing Regional Capabilities for a Sustainable Uranium Mining Industry (AFRA)' and INT2019, 'Deploying Technology and Management of Sustainable Uranium Extraction Projects', the Agency provided support to over 25 countries in 2019. Four interregional workshops with over 125 participants were organized, which facilitated the exchange of experience on feasibility studies and project management for the development of uranium mines and mills, conventional uranium production (from exploration to closure), environmental management of uranium mining and milling activities, life management and governance of uranium production and other activities involving naturally occurring radioactive materials for the sustainable production of uranium.

In support of the plan for nuclear power development in Saudi Arabia, the Agency organized a national workshop in 2019 to develop the framework and key considerations of a policy and strategy for the front- and back-ends, through the project SAU2009, 'Developing the Infrastructure for the Nuclear Power Programme'.

Radiation Protection and Nuclear Safety

REGIONAL HIGHLIGHTS

Nuclear science and technology offer a unique and strategic advantage in various sectors in the social, economic, and environmental development and the use of radiation sources has become widespread in Africa. To fully maximize the contribution of nuclear science and technology as a catalyst for development, Member States' capacities should be enhanced to improve their radiation safety infrastructure for safe and secure use of radioactive sources.

Radiation safety continues to be a priority area in the Asia and the Pacific region, and the TC programme is working with Member States to establish a network of national experts with diverse knowledge and skills: legislators and regulators, medical professionals, scientists, industry leaders, emergency response personnel and many others. Their common safety objective is to protect people and the environment from the harmful effects of ionizing radiation. Comprehensive assistance through training, the provision of tools, and the revision of national nuclear laws and regulations were carried out throughout 2019.

The Europe and Central Asia region has a dense concentration of nuclear and radiation facilities, operated and regulated by independent national organizations and authorities. Such close geographical proximity determines nuclear and radiation safety as a concern that all Members States in the region share and address. With regards to enhancing the capacity of the countries in the region to implement the basic requirements for radiation protection and safety related to medical exposure, the IAEA has provided training and assistance on justification of medical exposure, optimization of protection and safety, and protection of pregnant and breast-feeding patients, among others.

Environmental protection also continues to be a top priority for governments and the general public in the Europe region. Many national projects are complemented by regional project activities in decommissioning and environmental remediation. Other projects address, for example, radioactive waste management and naturally occurring radioactive material. In 2019 the Agency's support continued to focus on setting up infrastructure and enhancing national capacity for decommissioning and environmental remediation, as well as radioactive waste management or naturally occurring radioactive material, particularly in regard to human resource development.

Radiation protection and nuclear safety remains a priority area in the Latin America and Caribbean region, after human health and nutrition. The increasing use of nuclear science and technology in the countries of the region requires a strategic approach, to not only ensure the peaceful, but also the safe use of ionizing radiation for beneficial purposes in medical and industrial practices. Nineteen national projects in this topic area are helping countries to achieve specific goals in strengthening regulatory and safety infrastructure, while two regional projects strengthen cooperation among regulatory bodies and end-users, and strengthen the capacities of technical support organizations. A dedicated regional project is supporting the exchange of experiences among IAEA-CARICOM Member States to foster cooperation in building the governmental, legal and regulatory framework for safety. Radiation protection and safety was included as an essential part of the first Regional Strategic Framework (RSF) for the Caribbean, 2020–2026.



“To fully maximize the contribution of nuclear science and technology as a catalyst for development, Member States’ capacities should be enhanced to improve their radiation safety infrastructure for safe and secure use of radioactive sources.”

GOVERNMENTAL REGULATORY INFRASTRUCTURE FOR RADIATION SAFETY

During 2019, with assistance from national projects as well as regional project RAF9058 ‘Improving the Regulatory Framework for the Control of Radiation Sources in Member

States', the number of African countries exhibiting good progress with regard to their regulatory infrastructure has increased to nine. Progress is measured against indicators related to Thematic Safety Area 1 of the International Basic Safety Standards.

The Agency provided support to Lao People's Democratic Republic under projects LAO9002, 'Developing a National Infrastructure for Radiation Safety' and INT0096, 'Establishing and Enhancing National Legal Frameworks for the Safe, Secure and Peaceful Use of Nuclear Energy and Ionizing Radiation', to assist the Government of Lao People's Democratic Republic in adopting its comprehensive nuclear law, which was promulgated in 2019. The Agency is also helping Bahrain to develop a nuclear law and an independent nuclear regulatory authority to cover the whole spectrum of nuclear and radiological uses, with the support of project BAH9008, 'Improving the Regulatory Infrastructure for Radiation and Nuclear Safety'. In 2019, the legal experts trained under the project prepared a draft version of the law.

Through project BRU9001, 'Establishing the National Regulatory Infrastructure and Developing Technical Capacity for Radiological Emergency Preparedness and Response', the Agency is assisting Brunei in improving its national radiation safety infrastructure in line with the IAEA Safety Standards. The Agency is helping the Safety Health and Environment National Authority to gradually establish full capabilities for the radiation regulatory agency. In 2019, radiation emergency preparedness was enhanced through the provision of inspection instruments and personal radiation detectors, and a new Radiation Safety Information Management System coordinator was nominated and trained.

Indonesia's Regulatory Body, the Nuclear Energy Regulatory Agency, is receiving support through TC project INS9027, 'Strengthening Regulatory Capacity and Enhancing Effectiveness for Nuclear and Radiation Safety', to strengthen the national regulatory infrastructure relevant to the construction and operation of an experimental power reactor and future nuclear power plant. A follow-up Integrated Regulatory Review Service mission, conducted at the end of 2019, further strengthened the Nuclear Energy Regulatory Agency's capacity to accomplish its regulatory objectives and meet regulatory challenges by focusing on the improvement of its regulatory effectiveness and capability.

Under the project JOR9017, 'Strengthening National Nuclear Regulatory Capabilities for Nuclear Safety', the IAEA supported the national regulator in Jordan, the Energy and Minerals Regulatory Commission, in establishing and reviewing the licensing and inspection procedure for the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME). This action will be instrumental in further enhancing the safe operation and utilisation of SESAME.

In Oman, the Agency provided support for completion of the national regulations for the safe transport of radioactive materials, which will go through an approval process and publication in 2020, under OMA9005, 'Strengthening the Radiation Safety Infrastructure and its Supportive Technical Capabilities'. For the first time, a training event was organized for all radiation protection officers in medical practices by the Oman Ministry of Health. The training helped establish a clear understanding of the role and responsibilities of radiation protection officers in medical practices, as well as the tasks to be undertaken by radiation protection officers and their relationships with other members of the medical teams.

A regional train-the-trainer courses for radiation protection officers took place in two languages in parallel (English and Russian) in Tallinn, Estonia in October under project RER9142, 'Establishing Sustainable Education and Training Infrastructures for Building Competence in Radiation Safety'. The courses aimed to develop the participants' capacities to act as trainers, so soft skills were also addressed, as well as practical exercises. The courses have contributed to building a corps of national trainers in radiation protection to support the establishment of sustainable national infrastructures for training radiation protection officers in medical and industrial facilities.

In Georgia, the Agency is helping to improve national regulatory oversight and response capabilities through project GEO9016, 'Improving Regulatory Oversight and Response

Capabilities', which contributes to ensuring radiation protection and safety in the country. In 2019, the project supported the review and update of regulations as well as the development of capacities to implement authorization procedures, and the elaboration of further regulations. Advice was also given on putting the findings of the Integrated Regulatory Review Service (IRRS) mission into practice. The country's emergency preparedness and response capabilities were improved through training and the provision of emergency response equipment and devices.

The Agency continued to support the efforts of Caribbean Member States to establish national registers of radioactive sources through expert missions and the procurement of servers for the Regulatory Authority Information System (RAIS). RAIS promotes a consistent and common approach to the regulatory control of radiation sources while offering the flexibility to respond to the specific needs of Member States with respect to their national legislative frameworks, administrative structures and institutional and regulatory frameworks. In 2019, national registers were established in Barbados, Grenada and St. Vincent and the Grenadines. RAIS servers were procured for Barbados, the Bahamas, Guyana and St. Vincent and the Grenadines. The RAIS servers for Antigua and Barbuda and the Bahamas were customised and the staff of their national authorities trained in its use. In addition, Curaçao, with support from the Netherlands, established its national register with a customised RAIS server.

The regional project RLA9084, 'Strengthening the Regulatory and Radiation Safety Infrastructure', aims to improve regulatory and radiation safety infrastructure in Latin America and Caribbean, emphasizing the responsibilities and processes of the regulatory body and the implementation of the requirements of the IAEA Safety Standards. Through project activities implemented during the year, participating Member States enhanced their ability to develop and implement emergency preparedness and response arrangements for nuclear and radiological emergencies. Other activities carried out increased awareness of emerging issues in radiation safety and how best to update national legislation and guidelines to ensure their alignment with the International Basic Safety Standards. National capacities were improved for the safe transport of radioactive material, and aligned with national requirements and procedures. In addition, the capacities of Member States in the predisposal management and disposal of radioactive waste improved. Trainings and meetings held throughout the year enhanced capacities to develop national strategies for education and training in radiation, transport and waste safety, according to the Safety Reports Series No. 93. Participating Member States also improved their capacities to align with international safety standards and use good practices for the regulatory control of activities involving naturally occurring radioactive material.

Jamaica is continuously improving its governmental, legal and regulatory framework for radiation safety, seeking compliance with international safety standards. After the entry into force of the Nuclear Safety and Radiation Protection Act, the Hazardous Substances Regulatory Authority (HSRA) of Jamaica was established in 2017. As an independent agency, the HSRA's objective is to effectively regulate practices and facilities using ionizing radiation and nuclear technology, protecting workers, patients, the public and the environment. In September 2019, the Nuclear Safety and Radiation Protection Regulations entered into force. Assistance received through the technical cooperation programme enables HSRA staff to discharge their regulatory functions in accordance with national regulations. This



Fellows training on the practical aspects of implementing IRRS recommendations and on authorization procedures in Romania. (Photo: Agency of Nuclear and Radiation Safety, Georgia)



Representatives of the Ministry of Health, the Planning Institute of Jamaica and the IAEA visit the HSRA in November to review the progress made and coordinate future activities. (Photo: N. Schloegl/IAEA)

is important in connection with other project activities, such as the re-establishment of a nuclear medicine service at the University Hospital of the West Indies.

SAFETY OF NUCLEAR INSTALLATIONS

The inspection process is one of the key functions of a regulatory body, providing qualitative and reliable information to be sure that operational activities are performed in accordance with regulatory requirements, standards and good practice. If deviations in operator activities are found, the regulatory body should be able to use appropriate regulatory actions to correct these deviations and improve nuclear safety. To achieve objective and high-quality inspection results, regulatory bodies should assure that they have adequate inspection competence and experienced human resources to cover all safety areas. The regional project RER9152, 'Enhancing Inspection Capabilities in Nuclear Safety', was initiated to assist countries in Europe and Central Asia to enhance their oversight of nuclear facilities through inspection and enforcement. It provided capacity building activities in inspection and oversight from construction and commissioning to initial operation of the nuclear power plants, approaches to conducting interviews during the inspection of nuclear and radiological facilities, consistency and benchmarking of the regulatory inspection programmes and other important topics. These capacity building activities have contributed to the further development and enhancement of the regulatory infrastructure in countries in Europe and Central Asia.

'A national workshop focusing on lessons learned with regard to regulatory oversight for the construction of the first NPP was organized by the Agency in 2019 to support the Nuclear Regulatory Authority in Turkey to develop competencies for the regulatory oversight of Akkuyu NPP Project at Ankara. The workshop was supported through TUR9021, 'Enhancing the Atomic Energy Authority's Capabilities for Regulatory Oversight of Construction, Commissioning and Operation of New Nuclear Power Plants'.

RADIATION PROTECTION OF WORKERS, PATIENTS AND THE PUBLIC

An e-learning course on the radiation protection of patients was developed with the support of RAF9059, 'Strengthening Member State Technical Capabilities in Medical

Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards (BSS), and has subsequently had an international impact. The course was developed by African professors of radiography, and the first module, 'Tips and Tricks for Radiographers', was launched in 2019. This module has recorded 1283 registrations for the training, and has awarded 669 certificates to those who have completed the course.

The regulatory infrastructure of Kyrgyzstan is being improved through project KIG9006, 'Improving the Regulatory Infrastructure for Ensuring the Radiation Protection and Safety of the Population'. In 2019, the capacities of the State Regulation Centre on Environment Protection and Ecological Safety were enhanced to support the development and review of laws related to radiation safety, as well as authorization and inspection procedures. The status of authorities with regulatory functions was revised and mapped to avoid gaps and duplications. In addition, five inspectors from the Department for Radiation and Nuclear Safety of the State Inspectorate for Environmental and Technical Safety received practical training and developed procedures. Finally, the Department for State Sanitary Epidemiological Control of the Ministry of Health and the National Centre of Oncology acquired knowledge for reviewing and assessing applicant's submittals for the authorization in nuclear medicine, as this is a new service that will soon start operating in the country. The project also supported the regulatory body in verifying linac shielding calculations and helped to assess training and software needs for building national capacity to verify linear accelerators and other facilities shielding calculations on their own.

TRANSPORT SAFETY

A number of scientific visits were organized under AZB9010, 'Strengthening Legislation for Safety and Security of Radioactive Material During Transportation', to train selected staff of the regulatory authority in Azerbaijan in core regulatory processes as applied to the safe transport of radioactive material. These scientific visits were hosted by the Turkish regulatory authority, and interviews and lectures were provided. The visitors learned about the regulatory requirements for the safe transport of radioactive material, practical implementation of regulatory requirements, safe and secure transportation of radioactive material, as well as receiving in depth training based on the job duties and objectives of the individuals.

EMERGENCY PREPAREDNESS AND RESPONSE

Thirty-one health professionals from 19 countries in the Europe region received training in May 2019 at a regional workshop on medical preparedness and response for a nuclear or radiological emergency hosted by the Government of Cyprus and organized under RER9151, 'Updating and Harmonizing Emergency Preparedness and Response Plans'. Participants were trained on how to be prepared and ready to respond from a medical perspective in a nuclear or radiological emergency.

A new IT tool was developed for conducting radiological safety assessments in both medical and industrial facilities within the framework of RLA9085, 'Strengthening Regional Capabilities for End Users/ Technical Support Organizations on Radiation Protection and Emergency Preparedness and Response in Line with IAEA Requirements'. The Tool Kit for Safety Assessment (TOKSA) was presented at a regional training course on safety assessment in medical and industrial facilities, held in Mexico in October 2019. TOKSA will be improved based on user feedback at the regional training course, before being widely shared throughout the region in 2020.

RADIOACTIVE WASTE MANAGEMENT, DECOMMISSIONING AND ENVIRONMENTAL REMEDIATION

Singapore's National Radiochemistry Laboratory was established in 2017 and started operations in early 2018. Through project SIN9025, 'Strengthening Capacity in Radiation Protection and Radiation Monitoring - Phase II', Singapore received technical assistance from the Agency to build its capacities in the use of radiochemistry to analyse environmental samples. Support included a group fellowship on environmental sampling and analysis, and group scientific visits on emergency preparedness and response. Experts missions were also dispatched to the country to provide technical assistance on the development of storage sites for radioactive contaminated waste. Singapore has now developed a core team of dedicated scientific officers to sustain and further enhance its efforts for strengthening national radiation protection and monitoring capacity.

The Agency has helped the Government of Iraq to analyse the characterization data from the destroyed IRT-5000 Research Reactor, through project IRQ9011, 'Decommissioning and Remediation of Former Nuclear Facilities and Sites, Phase II'. A technical meeting in June 2019 provided the necessary technical support and guidance to the regulatory body and operator to conduct the necessary decommissioning planning of the reactor.

A workshop on decision methodologies for the management of RADON-type facilities was organized in November in Moscow, Russian Federation, within the framework of RER9143, 'Enhancing Radioactive Waste Management Capabilities'. The workshop covered all activities associated with past practices and old facilities for disposal of institutional radioactive waste that require licensing, and for which safety assessment(s) should be performed and safety case(s) should be developed and reviewed. During the workshop various approaches and decision-making methodologies for management of such old facilities, including RADON-type facilities, were considered.



Participants from the training course on international requirements and national practices of management of contaminated material in terrestrial and freshwater environments of Chernobyl-affected areas, October 2019, Vienna. (Photo: A. Radin/Russian Research Institute for Silviculture and Mechanization of Forestry)

The countries of Belarus, Russian Federation and Ukraine are receiving support for the long term management of contaminated terrestrial and freshwater environments of the Chernobyl-affected areas through RER7010, 'Improving the Remediation and Management of Terrestrial and Freshwater Environments Affected by Radioactive Material of Chernobyl Origin'. The project has trained specialists on international requirements and national practices regarding the long term management of contaminated material in terrestrial and freshwater environments. It has also enabled the comparison of public information practices regarding safe living on radioactively contaminated territories and on practices of management of the radioactive materials resulting from the use of contaminated wood. The affected countries have also been able to exchange and review their national experiences and existing practices for improving the remediation and management of the sites, resulting in the development of material that

is shared in the available online resources (chernobyl.info and Wikipedia article) on the consequences of the Chernobyl accident.

The capacities of European and Central Asian Member States to plan and implement decommissioning projects for small facilities are being supported under RER9146, 'Enhancing Capacities in Member States for the Planning and Implementation of Decommissioning Projects'. In 2019, young professionals from the region were trained in radiological characterization of small medical, industrial and research facilities, as

part of preparations for their decommissioning. The project also provided a platform for discussion and exchange of information, knowledge and lessons learned in the planning for decommissioning of these type of facilities.

In 2019, RER9150, 'Improving Capabilities to Efficiently Implement Large Ongoing Decommissioning Projects and Waste Management with Minimization of Risks Based on Initiatives and Potential Synergies', helped to improve the understanding of decision makers about the role of project management in implementing decommissioning projects. Best practices were shared and experiences in the region were exchanged on the use of quality management systems to improve operational procedures of radioactive waste treatment centres. The project supported the exchange of experiences on characterization of areas within nuclear facilities that have been affected by the consequences of accidents, or areas with high levels of contamination or high dose rates. In addition, it supported a discussion about the selection of adequate technologies to address specific waste streams, including problematic and legacy waste. The knowledge and skills of the participating specialists were also enhanced in the development, implementation and decision-making process for selecting decontamination techniques of large components and structures, including transuranium contamination, based on multi-criteria analysis.



Dismantling activities in the turbine hall of the Kozloduy NPP Units 1-4 is nearing completion, Kozloduy, Bulgaria, November 2019. (Photo: State Enterprise Radioactive Waste, Bulgaria)

In order to protect the public and the environment from the potential adverse effects of ionizing radiation, project SRB9005, 'Establishing a Reference Center for Radioactive Waste Treatment and Disused Radioactive Sources Conditioning for Small Facilities', has helped the public company 'Nuclear Facilities of Serbia' to implement a safer, more secure approach to the treatment of radioactive waste and the conditioning of DSRS. Local staff were trained to prepare, install and utilize mobile units for conditioning of DSRS, and expert support was provided for the design of the mobile units, preparation of the generic safety assessment, and preparation for the license of the mobile units. As a result of this assistance, two mobile units were upgraded: a light commercial vehicle to use as a mobile unit for dismantling of ionizing smoke detectors, and an upgraded ISO container to use as a mobile unit for conditioning of DSRS category 3 to 5.

The legacy radioactive waste inadequately stored in a radon type facility has been a matter of concern of the Government of the Republic of Moldova for many years. In 2017, a National Strategy on Radioactive Waste Management was approved, which included establishment of the relevant decommissioning infrastructure and planning the decommissioning activities. The project MOL9008, 'Building Operational and Institutional Capacity in Decommissioning, Remediation and Radioactive Waste Management Processes', is focused on designing the infrastructure for decommissioning, planning

decommissioning and remediation activities, enhancing operational capacity in safety case and safety assessment development and strengthening capacities in characterization of radioactive waste. During project implementation, several statements of work needed for safe management of radioactive waste in the Republic of Moldova were developed, namely for development of a detailed decommissioning and remediation plan for the closed near surface radon type disposal facility, on design planning of the storage infrastructure and on developing and implementing a quality management system for the Moldovan waste management organization, as well as for development of a prefeasibility study on the use of the final disposal system for legacy and radioactive waste. In addition, some individual trainings (fellowships and scientific visits) of representatives of the operator and regulator were organized to collect information necessary for the development of a detailed decommissioning and remediation plan.

Two expert missions were conducted under TUR9021, 'Enhancing the Atomic Energy Authority's Capabilities for Regulatory Oversight of Construction, Commissioning and Operation of New Nuclear Power Plants' to discuss the results of the review on Draft Radioactive Waste Management Regulations. The first reading was mainly aimed at checking the comprehensiveness of the draft regulations and if the terminology was being used in a systematic manner. Review comments were provided on the improvement of regulatory approaches and regulations, especially in the fields of siting, commissioning, and modifications.

Implementation of an environmental monitoring system focused on the impact of forest fires in the Belarusian part of the Chernobyl nuclear power plant exclusion zone is being supported through BYE9024, 'Controlling the Impact of Fires on the Public and the Environment in the Belarusian Site of the Exclusion Zone of the Chernobyl Accident and Adjacent Territories'. Experts recruited by the Agency supported the counterpart institution in elaborating an environmental monitoring system and an impact assessment for forest fires in highly contaminated areas and on the use of contaminated wood. A national training course for laboratory staff who will respond in the case of a forest fire in that area was held in Khoyniki in 2019. In addition, senior staff members were trained in the Russian Federation and Ukraine to assess the effects of forest fires and on the development of a network for public information on forest fires impact. In addition, a fully equipped mobile laboratory was provided under the project, together with environmental monitoring equipment.

UKR9037, 'Development of Decommissioning and Environmental Remediation Strategy and Capacity Building towards the Remediation and Decommissioning of Former Uranium Mining and Production Sites' aims to establish a sound infrastructure for the decommissioning and remediation of uranium mining and production facilities in Ukraine. The Smolinska Mine of State Enterprise 'VostGOK' is currently developing the Vatutinske uranium ore deposit, and operations are expected to be halted by the end of 2020. At this stage the facility will need to be decommissioned and the site remediated. In the framework of this project a workshop on Stakeholder Engagement for Remediation of Smolinska Mine was organized in 2019. Two experts worked with VostGOK and local public authorities to develop a draft communication strategy addressing techniques for engagement with the public (e.g. in relation to radiation safety), the social impacts of mine closure, and the roles and responsibilities of interested parties. In addition, site specific criteria for environmental parameters (atmospheric air, groundwater, surface water, soils) for the industrial site were established during the workshop and a methodology for radiological surveys was developed. Recommendations and lessons learned from the workshop are now being implemented.

300. Romania has received capacity building support to implement a near surface repository project under ROM9037, 'Supporting Radioactive Waste and Spent Fuel Management'. The repository will hold short-lived radioactive wastes resulting from the operation of Cernavoda NPP. A major milestone was reached in 2019 with the development of the waste acceptance criteria for the near surface repository.

Nuclear Knowledge Development and Management

Human resource development is a priority in the African region. The successful implementation of nuclear-technology related programmes requires the training of skilled mid-level personnel such as engineers and technicians through on-the-job and academic programmes. This will contribute to the effective operation and utilization of available and future facilities in Africa and help Member States to maximize the peaceful use of nuclear science and technology for their socioeconomic development.

Building, collecting, maintaining, sharing, preserving and utilizing knowledge is important for Member States in the Asia and the Pacific region, particularly as regards gaining the necessary technical expertise and competencies required for nuclear power programmes and the application of other nuclear technologies. The technical cooperation programme in Asia and the Pacific collaborates with Member States to maintain and preserve nuclear knowledge institutional memory by establishing platforms for Member States to exchange knowledge, promoting nuclear science and fostering interest in nuclear science and technology, including among secondary students.

In Europe and Central Asia, the technical cooperation programme supports the development, maintenance and exchange of knowledge and technical expertise in four thematic areas: nuclear and radiation safety, including nuclear installation safety, radiation protection, emergency preparedness for nuclear or radiation emergencies and nuclear security; nuclear energy, including nuclear power and fuel technology, waste technology, decommissioning and nuclear sciences; human health, including nuclear medicine, radiotherapy, medical imaging and medical physics; and isotope and radiation technology applications, including environmental, agricultural and industrial applications.

In the Latin American and Caribbean region, efforts are continuing to promote the education and training of young professionals in the field of nuclear science and technology. Innovative tools developed by countries participating in projects and disseminated within the framework of the Latin American Network for Education in Nuclear Technology (LANENT) are vital in attracting and training the new generation of nuclear scientists. The Agency also continues to strengthen strategic management and sustainability in national nuclear institutions. In addition, the regional programme emphasizes gender equality in all activities and offers development opportunities for young women in the nuclear sector.

CAPACITY BUILDING, HUMAN RESOURCE DEVELOPMENT AND KNOWLEDGE MANAGEMENT

The second Regional Meeting of Vice-Chancellors and Representatives of Regional Bodies Involved in Education and Training was held in Marrakesh, Morocco, in June 2019, supported by project RAF0052, 'Supporting Human Resource Development in Nuclear Science and Technology (AFRA)'. The meeting, hosted in collaboration with the Moroccan National Centre for Nuclear Energy, Sciences and Technology, addressed areas of collaboration with African universities, with a view to increasing the number of graduates and postgraduates in Africa trained in nuclear science and technology. During the regional meeting, representatives of the World Bank, United Nations Educational, Scientific and Cultural Organization, World Academy of Sciences, Association of African Universities, and Vice-Chancellors of African universities discussed strategic partnerships for the effective and successful implementation of graduate and postgraduate academic programmes in Africa. Participants also agreed on actions to collaborate with the Agency to work towards the training of a critical mass of next generation African leaders in nuclear science and technology through sandwich PhD fellowship programme and other programmes in the



“The technical cooperation programme in Asia and the Pacific collaborates with Member States to maintain and preserve nuclear knowledge institutional memory by establishing platforms for Member States to exchange knowledge, promoting nuclear science and fostering interest in nuclear science and technology, including among secondary students.”



Vice Chancellors of African universities and representatives of regional bodies involved in education and training met under RAF0052 to examine ways to address human resource development needs in Africa. (Photo: M. Edwerd/IAEA)

region. Under this regional project, thirteen candidates (nine of which were from least developed countries, and five of whom were female) were awarded sandwich PhD fellowship training to carry out their PhD research work in a foreign university.

The Agency is supporting Member States in Asia and the Pacific in mainstreaming nuclear science and technology within their plans for national development under the regional project RAS0080, 'Promoting Self-Reliance and Sustainability of National Nuclear Institutions.'

In the Europe region, within the framework of the regional project RER0043, 'Enhancing Capacity Building Activities in the European Nuclear and Radiation Safety Organizations for the Safe Operation of Facilities', capacity building activities to ensure safe operation of nuclear and radiation facilities were implemented in 2019. One event that took place was the Regional School of Nuclear and Radiological Leadership for Safety that enables junior and middle management professionals to learn and apply leadership concepts for safety in their respective organizations. The participants enhanced their ability to lead people in nuclear and radiological working environments, which feature inherent complexities and often competing considerations. One of the major outcomes of the school is the increased ability of the participants to effectively engage and constructively influence others on safety matters, both in routine and emergency situations.

In the Czech Republic, nuclear knowledge development is a priority due to an increasing demand for nuclear personnel in parallel with the ageing of experienced staff. Through the national project CZR0009, 'Strengthening Human Resources Capacity, Nuclear Knowledge, Skills Preservation, Supplementary Enlargement of Knowledge and Expertise in Relevant Fields of the Peaceful Use of Nuclear Energy', training opportunities were provided with the goal of ensuring the safe, sustainable and reliable operation of institutions and services in the nuclear field. Three fellowships were realized in 2019, enabling young professionals to improve their skills at institutions abroad. Upon completion of their fellowships, the graduates were able to use their new knowledge and practical experience at their institutions in the Czech Republic.

The Agency provides support to the LANENT through project RLA0057 'Enhancing Nuclear Education, Training, Outreach and Knowledge Management'. The project has made an essential contribution to preserving, promoting and sharing nuclear knowledge, as well as fostering nuclear knowledge transfer in the Latin American region in areas such as education, health, industry, agriculture, the government, the environment and mining industry. The network also seeks to communicate the benefits of nuclear technology to the public, aiming to stimulate interest in nuclear technology in younger generations. In July

2019, representatives from LANENT joined representatives from other regional educational networks in Vienna in order to share best practices and enhance interregional cooperation.

In the framework of RLA0057, LANENT has developed a multimedia educational programme (NUCLEANDO) that equips both primary and secondary school teachers with pedagogic tools and resources, allowing them to introduce nuclear and isotopic sciences into their curricula in an engaging and innovative manner, and to clearly demonstrate the benefits of peaceful applications of nuclear technologies to younger generations. The NUCLEANDO programme was first introduced as a pilot course in July 2019 in San José to demonstrate the applicability of the programme to Costa Rican educators. Further courses have been scheduled for early 2020 in Chile and Uruguay with the aim to ultimately encourage and expand the engagement of 250 000 young students with nuclear science and technology by 2021. Seven participants from the region were sponsored under the project to attend the 15th Nuclear Knowledge Management School, hosted by the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy, in August 2019. This training is intended for young professionals with current or future leading roles in the management of nuclear knowledge.

A Knowledge Management Assist Visit (KMAV) took place at Electronuclear (Angra, Brazil) in April 2019 within the framework of project RLA9083, 'Enhancing Nuclear Power Plant Life Management and Safety Culture Practices'. This integrated IAEA service is designed to assist Member States in maintaining and preserving knowledge in nuclear organizations. The KMAV reviewed the established knowledge management practices at Electronuclear for long term operation and provided the organization with expert advice on further improvement. A specific action plan was developed to support Electronuclear with the improvement of its nuclear knowledge management system. Following the success of this initiative, Argentinian and Mexican NPPs have also expressed their interest in implementing similar missions to improve their nuclear knowledge management practices.



Left: Science teachers utilizing NUCLEANDO material during the training of trainers of July 2019 in San Jose, Costa Rica. (Photo: E. Genini/IAEA). Right: Secondary students learning with NUCLEANDO material after it was adapted to fit national curricula. (Photo: A. Morales Campos/Gravilias School, Desamparados, Costa Rica)

Annex 2. TC Programme Fields of Activity³⁴

Nuclear Knowledge Development and Management
Capacity establishment, programme knowledge management and facilitation of cooperation among Member States (01)
Building national nuclear legal infrastructures (03)
Industrial Applications/Radiation Technology
Reference products for science and trade (02)
Research reactors (08)
Radioisotopes and radiation technology for industrial, health-care and environmental applications (18)
Accelerator technology (32)
Nuclear instrumentation (33)
Energy
Energy planning (04)
Introduction of nuclear power (05)
Nuclear power reactors (06)
Nuclear fuel cycle (07)
Food and Agriculture
Crop production (20)
Agricultural water and soil management (21)
Livestock production (22)
Insect pest control (23)
Food safety (24)
Health and Nutrition
Comprehensive cancer control (25)
Radiation oncology in cancer management (26)
Nuclear medicine and diagnostic imaging (27)
Radioisotopes and radiopharmaceuticals production for medical applications (28)
Dosimetry and medical physics (29)
Nutrition for improved health (30)
Water and the Environment
Water resources management (15)
Marine, terrestrial and coastal environments (17)
Safety and Security
Governmental and regulatory infrastructure for radiation safety (09)
Safety of nuclear installations, including siting and hazard characterization (10)
Governmental and regulatory infrastructure for nuclear installations safety (11)
Radiation protection of workers and the public (12)
Transport safety (13)
Nuclear security (14)
Emergency preparedness and response (16)
Radioactive waste management, decommissioning and remediation of contaminated sites (19)
Radiation protection in medical uses of ionizing radiation (31)

³⁴ Updated in 2020 for the IAEA TC programme 2022–2023. The field of activity number is shown in parentheses.



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

International Atomic Energy Agency
Vienna International Centre, PO Box 100
1400 Vienna, Austria
Tel.: (+43-1) 2600-0
Fax: (+43-1) 2600-7
Email: Official.Mail@iaea.org

www.iaea.org/technicalcooperation

